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SEA-SICKNESS

A
COMPREHENSIVE TREATISE
FOR
PRACTICAL USE

BY
HERMAN PARTSCH, M.D.
EX-SURGEON OF THE STEAMSHIP "ALAMEDA"
MEMBER AND PRIZE ESSAYIST (1886) OF THE
MEDICAL SOCIETY OF THE STATE
OF CALIFORNIA



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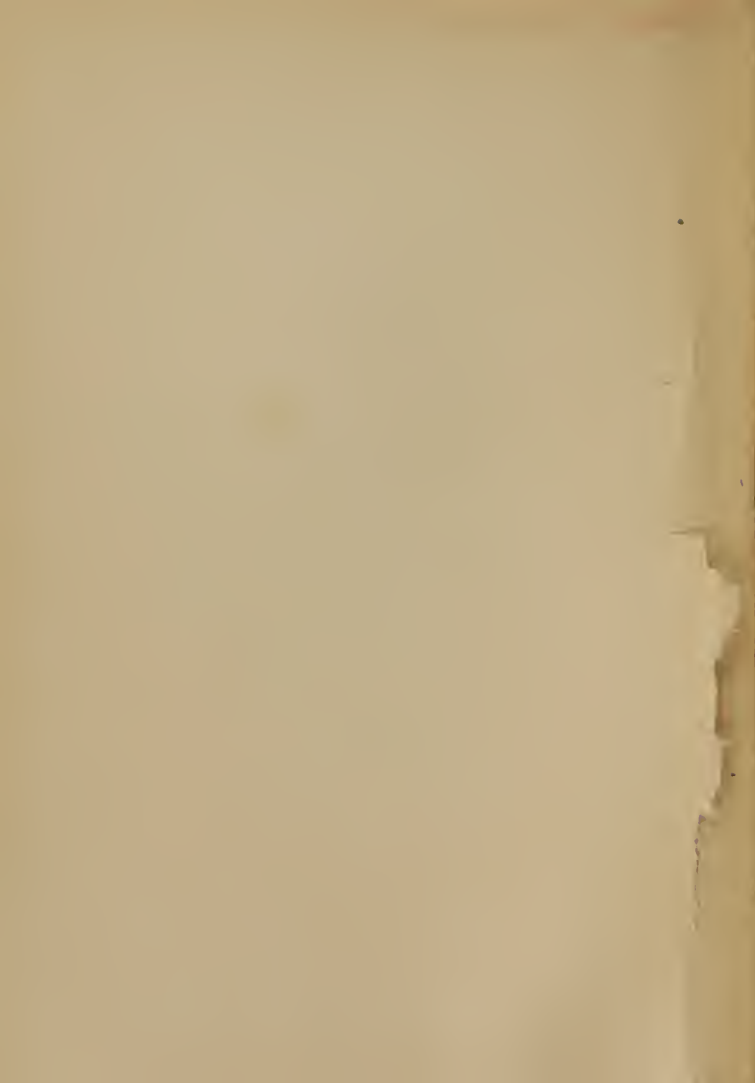
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To
A VERY MAGNANIMOUS PATRON OF MEDICAL SCIENCE
AND A MOST EMINENT PRACTITIONER
OF THE HEALING ART
PROFESSOR LEVI COOPER LANE
A.M., M.D., M.R.C.S.

This Book is Dedicated
BY
THE WRITER

380574



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PREFACE.

SEA-SICKNESS has had a share of my attention for seven years.

The basis upon which my study was *begun* was as follows: I made four steamship trips on the Californian coast, of durations of nine, twelve, sixty, and sixty hours respectively, at times extending from 1876 to 1883. I have twice been thoroughly sick by riding inside of stage-coaches: at the age of fifteen, with a coach full on a long distance; and at the age of twenty-seven, with three of us in the coach and a run of twenty miles; the roads were hilly in both cases.

I always got dizzy in swings and elevators in a short time; and at the age of ten years, suffered a decided motion-sickness on my first considerable ride on a railway train.

Upon this limited, but sufficient basis of expe-

rience, supplemented by data personally obtained from many individuals, and from the scanty and crude literature of the subject, is founded almost all of what the following pages contain on the *causes* of sea-sickness, and the conditions and manner of their operation, — in medical parlance, the *etiology* of sea-sickness.

When, after four years of slow growth, the etiology had assumed the form in which it is now presented, I determined to go to sea for a more varied, extensive and fresher experience and to test my conclusions, but chiefly to observe the symptoms, get their signification, and try to see if sea-sickness might be avoided more or less completely, with the assistance of an understanding of its etiology. It is due to several scientific gentlemen that, after waiting sixty days, I was settled in one of the favorite cabins of one of the finest steamships on the Pacific — the “Alameda” — with a complement of officers that were able, intelligent, congenial, and fitly corresponded to the general and special excellence of the young, but full-grown steamship. I served as surgeon for one year.

What the following pages contain on symptoms and management of sea-sickness, was developed during the year at sea. Had I not been

sea-sick in all stages during the first half of the year, this practical study would not have been a fruitful one. The practical outcome of the whole affair is that the intensity, violence or severity of sea-sickness can be reduced in any individual case to at least one-tenth of what it is without management.

References to authorities will show to what extent I am under obligations to them for data. I have appropriated no one's theories : I have had no use for them. Nor do I owe any theory of my own to anything suggested in the literature of sea-sickness. True, there are outcroppings, here and there, of very crude and crudely expressed ideas, which might have led to what I have presented on *disturbances of muscular adjustments, vascular disturbances, and optical vertigo*. But, as it was only after my second year of independent study that I began to read what there was on the subject, I had on these several topics proceeded nearly to their present stage of development, and therefore derived nothing from these outcroppings, which were generally but little more than arbitrary statements of belief without support of reason.

As an instance of the outcropping of a theory that I have developed, I will cite the best that I

have found (London *Lancet*, 1838, page 164 and farther).

The Medical Society of London, at a meeting in October, 1838, discussed (impromptu) the causation of sea-sickness. The report of that discussion in the *Lancet* is the best item of literature that the subject has heretofore had : —

“Mr. Dendy thought that members only took a partial view of the subject. The senses, no doubt, had often much to do with the matter; but, certainly, not always; persons had been awakened from sleep by the occurrence of sickness. Fear was not always present: the most courageous persons frequently suffering from sickness. It was well known that Nelson, who ‘never knew fear,’ was incapable, for many days, of leaving his berth from sickness, and Sir John Franklin was never able to take charge of his ship until he had passed the Bay of Biscay. He (Mr. D.) believed that the *cause* of sea-sickness existed primarily in the heart, an irregular action being produced in that organ, like that arising from concussion of the brain. The consequence was that the brain did not receive a sufficient supply of the circulating fluid, and the phenomena of sea-sickness were produced. This was proved to be the fact, also, from the circumstance

of the recumbent position in some measure preventing the sickness, the circulation in the brain being then more powerful. In syncope we placed persons in the recumbent posture to obtain this latter result. He believed that the circulation was primarily affected, but the subject of sea-sickness was involved in great obscurity.

“Mr. Leese thought that the sickness arose from some impression made on the brain, and probably through the medium of the circulation. He remembered an instance in which some old seamen, part of a ship’s crew, after rowing in a small boat for several hours, became very sick. These men were never sick when exposed to the motion of the ship to which they were habituated.

“Dr. Whiting thought that the sudden pitching of the vessel must have considerable influence in deranging the circulation, which affecting the brain, the stomach also became disordered. Secondary causes came in to hasten or to increase the effects.”

H. P.

629 Kearney St., San Francisco,
September, 1888.

SEA-SICKNESS.

CHAPTER I.

MOTIONS IN THE CAUSATION OF SEA-SICKNESS.¹

1. When a person goes up or down stairs in the dark and finds one step more or less than he expected, he suffers a well-known disturbance of muscular adjustment, with some more remote and less definite consequences of the same. When a person walks out on uneven ground and does the unusual thing of wearing spectacles which make the ground seem nearer to or farther from him than it really is, he suffers at each step a disturbance which differs from that in the preceding case only in degree. And if such person with such spectacles reach for a small object, guiding his hand by sight, he will either reach farther or short of the object. If a cannon

¹ An abridgment of this chapter received the first prize awarded by the Medical Society of the State of California.

ball were disguised by paint so as to appear as wood, and therefore very much lighter than it really was, and a person having no doubt that it really was wood attempted to pick it up, his hands would slip off without raising the ball. On the contrary, if it were very much lighter than it appeared to be, the person would lift it with unexpected ease, and himself and ball rise up with a disagreeable suddenness.

2. These things are disagreeable to experience, for even after one recovers his muscular adjustment there is plainly left a slightly disordered condition of the individual. The spectacle experiment has been by the writer and several friends continued to a series, by walks prolonged to such an extent that the accumulated effect of the series of phenomena had resulted in decided illness. A friend who is accustomed to using spectacles told me that he had on several occasions gone to his duty forgetting to take them. He becomes nauseated when going up or down stairs without them, and also when using his hands in prehension if he guide his movements by sight.

3. In those optical phenomena, in which there is an unusual modification of our usual means of vision, we get an erroneous notion of the distances that form a great part of the basis upon which our muscular adjustments in such cases are made. Distance is a factor in many muscular adjustments. A person is an expert geometer to the extent that his precision habit is developed, and still he may be very ignorant of the terms by which his intuitions of space are expressed in language. Muscular adjustments involving space are based only on the intuitions of that space, and this is entirely independent of that notion which associates itself with the lingual terms which designate that space. An erroneous notion of space involves an erroneous adjustment of the animal mechanism, and the result will be different from that expected.

4. Such difference between a result expected and a result realized is what constitutes a disappointment. Disappointments always result in violence.¹ (I use the general term *violence* to

¹I have met a few persons whose experiences seem to fur-

designate what might better, perhaps, be called *shock*.) The intensity of the violence varies with the magnitude of the difference between the expected and unexpected results.

5. When a muscular adjustment involves an erroneous notion of weight, the principle is scarcely different.

Experience gives us intuitions of weight; these we employ as a basis upon which we appropriate the requisite amount of power to accomplish the act. That one is always in danger of disappointment in any of these cases is not to be inferred; for these acts can be, as in childhood and in all first instances of any class, performed tentatively. A man, for example, about to lift for the first time one end of an iron rail, would make the effort without any preconceived notion of its weight; he would therefore take hold, deliberately apply a good deal of force to start with and then increase it until the rail yielded.

6. Expectations are temporary; that is, formed
nish exceptions to this statement. It may be because their expectations have not that fixedness upon which disappointments depend.

on and for an occasion. They are also habitual, and therefore more or less permanent. In this country, where earthquakes are few and far between, it is with us an habitual expectation that the grounds and floors we walk on retain their positions invariable. This very expectation does more than concern merely the mind; it is a detail of our instinct which we are in a short time unable to dispense with, or even interfere with when we try.

7. A disappointment, involving this habitual expectation, with its consequent violence, may take place without the subject being conscious of it until he is made so by the nausea which takes place in response to the violence as a stimulus. The subject in such case does not even know the first cause of his illness; it is only after the whole group of phenomena have occurred, and have been explained on a previous occasion, that he is able by comparison to conclude in the event of a recurrence that the cause is of like kind. This is made clear by the following two quotations — “*Philosophical Transactions*,” vol-

ume 42, page 41, from Rev. Mathias Plant's "Letter to Rev. Dr. Bearcroft, concerning Earthquake Shocks near Newbury (New England), from the year 1727 to 1741 :—" "And I have frequently, in my conversation with sundry persons, been told by them, that for a few minutes before a shock of it came, they could foretell it by an alteration in their stomachs. I attest to the truth of the thing by my own experience."

From the same work, volume 51, page 610, on the same subject: "Preceding actual shock a few minutes, many people can foretell the occurrence of an earthquake by the change in the state of their stomachs apparently akin to that attending sea-sickness. And this disturbance always accompanies the wave-like motion of earthquakes when so gentle as to be uncertainly distinguishable by other ordinary means."

8. In walking on any deck of a ship at sea, inasmuch as the plane of such deck is constantly changing its relation to the vertical, no step can be taken simply by a repetition of the adjustment for preceding step. It is as if going up or

down stairs, the steps of which are no two alike in height. The labor of new adjustments probably taxes the mind and tends to fatigue. Even then no adjustment seems adequate, for by the time the foot reaches the point to which the adjustment was made to carry it, that point of the deck has changed position. The consequence is, just as in the spectacle experiment, a series of shocks, such as have been designated on a preceding page by the more general term *violence*.

9. Again, it is our constitutional habit to maintain a certain relation, when standing or sitting, between our long axis and the vertical; and it is contrary to our habitual expectation that any objective force interfere with such relation. But as at every instant the lines of the ship's deck change in respect of the vertical, we are with every such change thrown out of relation to the vertical, and suffer a disturbance of our muscular adjustment and slight shock. At every moment we readjust, and are as often thrown out of adjustment. This being contrary to an habitual expectation, there results a disap-

pointment from every such disturbance; and it is the accumulated sum of the effects of the separate shocks that constitutes the illness attending such experience.

So far I have considered only the effect, on the new passenger, of the changes of position of ships' decks in respect of the vertical.

10. While the complex cause of sea-sickness embraces several lesser factors, the chief one is motion. The motions that make us sick are a class that are distinguished very clearly from those that do not make us sick. I have arranged all motions to which the body can be subjected into *three* classes. It has not been necessary to *make* the class distinctions, but only to define them as they occur in nature. There is in this classification, therefore, nothing arbitrary.

A movement may be active or passive in respect of mind as certainly as it is so in respect of body. My classification is based on this fact, and accordingly —

Motions of class first are active mentally and
active bodily ;

Motions of class second are active mentally and passive bodily ;

Motions of class third are passive mentally and passive bodily.

In class first both the mental determination to move and the motive power are subjective. A typical example is walking on a level or up hill. In class second there is either a subjective determination to move or a consent to the movement, but the motive power is objective. A type of class second is a ride on a horse, whose motions are well known and therefore comprehended by the rider. Any passive motion to which the body is adjusted by nervous effort, volitionally and consciously, or automatically and unconsciously, belongs to class second. In class third both the determining cause and the motive power are objective. As typical of this class we may take any case in which a person is subjected to heterogeneous passive motion, no detail of which he is aware of nor understands beforehand, to which, on this account, he is utterly unable to adjust himself.

11. It is *invariably* motion of class third (passive mentally and passive bodily) that is followed by motion-sickness.

During continued motions of class third there is an equally continued succession of automatic efforts (conscious or unconscious) to accommodate the body and its parts to them. To the new passenger the ship's motions are of third class. No sooner is a motion adjusted to than it changes and throws the body out of adjustment, each such disturbance resulting in violence, the accumulated sum of which finally amounts to illness.

12. Third-class motions on ships are ordinarily such that each variation may be anticipated and adjusted for. The subject becomes cognizant of the variations chiefly by the tactile and kinæsthetic senses of whatever parts of the body are in contact with the object whose motion is communicated to him; by these means chiefly, and in addition, under some circumstances, by the sense of sight. Some attention to the motions facilitates the recognition of their variations.

Any variation recognized soon enough, the adjustment to it takes place automatically. The motions, being in the first place of third class, become motions of second class to the extent that the subject recognizes them and adjusts to them. To him who is for the first time on a ship the motions are of third class, while the same are to the experienced voyager motions of the second class: recognition of and adjustment to them in his case are automatic and unconscious.

13. It now seems quite plain that the sickness is not due to motion *per se*, else it would make the sailor sick also, because he is subjected to the same motion. And it is equally plain that the sickness is due to the condition which distinguishes third-class motions, namely, the condition of being passive mentally. Many persons get sick riding inside of stage coaches or carriages; I have been unable to learn of any one ever getting sick riding on the outside with the driver. The cause of sickness in staging lies evidently in the difference between riding in and

riding outside, and what is this difference? On the outside the subject foresees every start and stop, every curve in the road, every elevation, depression, and in fact everything that will influence the motion of the coach and therefore of himself. Foreseeing all these there occur in him accommodating adjustments in accordance. On the inside nothing is foreseen; therefore all the variations of motion affect the subject un-awares, each resulting in shock, which by accumulation amounts to illness.

“Aquatic birds of the greatest vigor in flight, and habituated to floating on stormy waves, often become nauseated on decks of vessels.” — (R. M. Bache.) I have been told by ship officers and passengers that such birds often get so sick immediately they alight on deck that they cannot fly off.

Here again the motion of the wave is second class to the bird, that of the ship is third class. The wave-motion is comprehensible; its changes are automatically and unconsciously anticipated and adjusted to; while on ship the motion,

though far less violent than that of the wave, is yet incomprehensible and cannot be adjusted to, and the bird suffers as any other passenger.

14. When a motion is uniform, and when direction or velocity, or both, vary uniformly, even though it be at the start third class, it quickly becomes second; because the laws of its variations are quickly observed if not very complex, the variations then expected and adjusted to. A motion, therefore (not regarding its start), may be of the second class and not make one sick when it occurs in a straight line, or in a uniformly curved line, at a uniform velocity, or a uniformly varying velocity. But its place in class second or third depends upon whether it is comprehended or not by the subject of it.

15. Our subject may, perhaps, be made more interesting by the consideration of third-class motions under some other circumstances. Many persons get sick swinging by their own efforts. More get sick when being swung, either by the efforts of another or by the momentum resulting from their own efforts. The complicated nature

of the swing-motion should be observed. It describes an arc of a circle and therefore changes its direction at every point. It consists of a forward start, accelerated movement, retarded movement, stop; backward start, accelerated movement, retarded movement, stop. Eight kinds for each round. And again, the tendency of the centrifugal force to produce cerebral anæmia increases with the acceleration and decreases with the retardation of the movements. Seeing that the motion is so complicated, it is easy to understand that it is incomprehensible to many persons; that such persons, being therefore unable to adjust to the motion, are made sick by it as by any other motions the variations of which are frequent and not foreknown. Many are not sick and others less likely to be so when the motion is active bodily. Active swinging involves more attention to the motion than does passive swinging. And it seems that this amount of attention brings the swing motion, entirely or nearly as the case may be, within the range of the comprehension of some persons.

But for many of us the determination to swing contributes little or no more toward adjustment to the variations and details than does the determination to sail insure adjustment to all the variations and details of the ship's motions. Therefore, whether one swings or is swung, the motion is third class to an extent which varies with individuals, and it partakes more of the third-class character when being swung than when swinging.

16. Some persons get sick on railway trains in motion. The frequency and severity of the cases are proportional to the frequency of curves and grades, and also to the speed. The variations dependent on curves and grades are third-class movements.

17. Not more than about one out of two hundred persons is exempt from becoming sick when subjected to rapid rotation in the upright or sitting position. Such rotation under such circumstances is third class motion. The more the whirling partakes of the voluntary and active character, the less the physiological disturbance.

But even in voluntary whirling there is an inseparable share that is third class, namely, that which results from momentum after the person has determined to stop and has ceased his efforts. The sickness of whirling and railway travelling is also very often complicated with optical vertigo, a subject considered later on.

18. That persons are made sick by the gentle and scarcely observable earth-crust movements with which earthquakes often begin has been shown (§ 7). The following more modern testimony on this point is furnished by Professor John Milne in "Transactions of the Seismological Society of Japan" for 1880, part I. page 15: "Many who are now present have heard pheasants scream a few seconds before we felt a shock, as if they had perceived approaching tremors to which we had been insensible. That such tremors do sometimes precede a shock we may infer from the gradual manner in which shakings sometimes have a commencement, and also from the fact that in certain houses, where the window sashes or slides are loosely fitted, a rattling will

be sometimes heard a few seconds before a shock is felt."

Part II. page 108: "Amongst the accounts of great earthquakes we find many well-authenticated records of the motion having been sufficiently great to produce a feeling of sickness and even vomiting. Mr. Mallet, in his report to the British Association in 1858, mentions an instance where an earthquake produced nausea and vomiting amongst all the pupils of a large school. From phenomena of this sort we do not appear to be exempt. One correspondent writes that at the time of the shock he felt a slight nausea. A similar feeling was experienced by a gentleman who was staying in my house at the time. Another writer says: 'I felt sea-sick, but am a bad sailor.' Another writes: 'The sensation was like that of sea-sickness, etc.' A near neighbor of mine says he felt quite sick. A resident in Yokohama reports an experience of the same sensation. Two cases of actual vomiting are reported."

Professor Milne reports still other cases, and

says that not all the cases thus occurring were heard from. Professor J. A. Ewing, of Japan, says earthquakes often begin very gradually.

19. On our hotel elevators we have upward and downward movements, upward and downward starts, and upward and downward stops—six kinds, and no two identical. The uniform movements up or down are not generally effective in causing illness. The starts and stops are very effective to those unaccustomed to elevators. To stay on an elevator in motion an hour would make a great many persons sick. There is a small balance of testimony to show that the downward starts are more efficient in producing nausea than the upward starts.

Sir C. Bell mentioned what any observing mother has noticed in her infant, namely, when the infant is held in arms and is carried up stairs it manifests no signs of uneasiness; when thus carried down stairs it gives unmistakable evidence of disturbance, even if necessary to awaken in order to do so. We, in common probably with all land animals, have during

early part of our lives had many misfortunes associated with downward motions. To associate an anticipation of evil with downward motion which takes us unawares is not only a constitutional habit, but a habit that is all the more potent as it is inherited by us from all preceding generations. But no one ever falls upwards.

20. On ship the motions are exceedingly complicated. There is a partial to-and-fro rotation about the long axis of the ship; it is called rolling. For each direction there is a start, movement, and stop. These are all different; they affect the subject differently, and require different adjustments in order to harmonize with them. Aside from starts, and stops, the movement is further complicated by being in each case accelerated in the first half of its length and retarded in the second half. To a single round of the rolling movement, we therefore have eight different motions, namely, start, accelerated movement, retarded movement, and stop, for half the round; and four more such motions in the opposite direction complete the

round to point of beginning. The curvature of this movement is still another complication.

21. This very brief consideration of the rolling movement applies also to the pitching, which is similar to the rolling, and corresponds to it in every detail. Its axis of rotation is the transverse axis of the ship. It rotates the long axis of the ship through a lesser angle than the transverse axis is rotated by the rolling, but the extreme ends of the ship rotate through a greater space.

The pitching and rolling then give us sixteen different kinds of motion, requiring as many different kinds of harmonizing adjustments on the part of the successful sailor; and the sailor executes these adjustments perfectly, automatically, unconsciously, and apparently without any deleterious expenditure of energy.

22. There is another class of ship movements, very similar to those of the elevator. This includes the up and down movements. Each round consists of downward start, accelerated movement, retarded movement, stop, upward

start, accelerated movement, retarded movement, stop. These eight, with those already given, constitute twenty-four movements of the ship, exclusive of progression and certain tremors.

23. Of tremors there are at least two varieties present on steamships. One is caused by the operation of the propelling machinery and is always present and nearly always uniform. It is customary for trial purposes to run the machinery slowly for a time, a few hours prior to departure on the voyage. The ship resting otherwise quietly at the wharf in still water, the tremor thus set up, though gentle and uniform, is quite sufficient to make many persons sick.

24. The other variety is variable and not always present. An understanding of it enables us to appreciate the cause of the greater prevalence of sea-sickness with winds ahead than with winds astern. With winds astern conditions vary with the relative velocities of ship and wave; velocity of the wave depending on the velocity of the wind. With wind, and therefore wave, directly astern, and velocity of wave and

ship equal, there are no wave impingements against the ship, and for this reason the ship in this case is free from what we may call the wave-impingement tremor. The ship is also free from this tremor during calms, when there are no waves because no winds. When velocity of wave is greater than the velocity of the ship, every wave that overtakes the ship makes an impingement, and the series of impingements gives rise to a tremor. And so, if the velocity of wave is less than the velocity of the ship, there will be a tremor caused by the impingements of ship against the waves which it is overtaking.

If we suppose two cases, in the one (*a*) a series of impingements by ship overtaking the waves, in the other (*b*) a series of impingements by waves overtaking the ship, and suppose that in each case the number of impingements in a given time are equal, then the violence of the tremor will be greater in case (*b*), as will appear by comparison of the cases thus: In (*b*) ship is struck by the leeward and therefore more

abruptly inclined side of the wave, and the stern of the ship presents a greater area of surface more nearly perpendicular to direction of the force of the impinging wave. In (*a*) the ship strikes wave on its windward and therefore less abruptly inclined side, and the bow of the ship presents its surface more obliquely to the direction in which it impinges upon the waves.

25. With winds and therefore waves ahead, because the ship and waves are moving in opposite directions, there is a greater number of impingements in a given time than with winds astern. The ship is also struck by the more abrupt side of the wave. In this case the momentum, and therefore the force, with which waves strike the ship is always great, and sometimes enormous. If wave and vessel, for example, are moving at the ordinary steamship rate in opposite directions, the momentum and force with which the wave strikes the ship are equal to that of a like wave of twice the velocity striking the ship at rest. What the force of such an impingement is, can best be appreciated

by those who have seen what destruction is sometimes wrought by a fragment of such a wave coming on deck.

26. Tremors are varied by changes of winds to other directions in respect of the vessel. With winds and therefore waves abeam, the ship rolls. When high and long waves ("swells") pass under it, the ship keeps its keel toward the centre of the wave. When, as in times of strong beam winds, there are smaller waves upon the "swell," such smaller waves impinging against the ship's side give rise to a tremor.

Other things equal, all that are at all susceptible are decidedly more sea-sick with winds ahead than when they are in any other direction. It is my opinion, based on observation, that on steamships, sea-sickness is least prevalent with no winds at all, and that the next most favorable condition is to have the winds directly astern.

27. The actual movement of a ship is a complication or resultant of nearly or quite all of the twenty-six details described. When all or nearly

all of the details of movement are present the resultant is exceedingly complex. The intensity of sea-sickness and the extent of its prevalence, among passengers and even crew, are proportional to the degree of complication of the motion. In other words, the greater the variety of details of movement, and the greater the number of variations of movement in respect of curvature, velocity, and direction, the greater the prevalence of sea-sickness.

28. Many persons believe that there is a difference between rolling and pitching in respect of their efficiency in producing sea-sickness. This difference is believed to exist irrespective of their relative amplitudes and violence. The difference that such people observe is only apparent. When a ship has been out several days or longer, rolling all the time, the passengers about well, and the motion then changes in a short time to pitching, the passengers will in as short a time suffer a relapse of sea-sickness, and conclude that pitching is the worse motion. A similar change from pitching to rolling, with

a like result, convinces other passengers that rolling is worse than pitching. In general that motion seems worst to which we are least subjected.

29. So far I have briefly indicated the condition upon which physiological disturbances depend, and have detailed the movements which under that condition cause such disturbances. We next wish to know how these motions cause these disturbances, and what these disturbances consist of.

There is only one department of the animal anatomy that can be reasonably believed to be disturbed primarily by motion; that is of course the fluid part; and of this there is ample reason for regarding the blood-vascular system as alone the seat of the primary disturbance. I use the expression *primary disturbance* to distinguish it from the nausea, etc., which latter result from the former as effect from cause.

30. Before proceeding further I must attempt to establish the data from which I conclude that the blood-vascular system is the seat of the

primary disturbance. There are a few points in cell physiology that must be borne in mind, and I will therefore briefly consider them. Corresponding to the two kinds of muscle fibres there are two kinds of cells. The cell of the voluntary muscle has three states; one state of rest, and two others which may be designated as the states of passive and active energy. A complete round of the phenomena of such a cell is as follows: The cell is in its state of rest; upon receiving the proper stimulus through the nerve fibre connecting it with brain or cord, it enters the state of active energy which consists of the evolution of force. When exhausted it immediately enters the state of passive energy, which consists of the appropriation of force. When charged, it enters the state of rest, in which it remains until the proper nervous stimulus is again applied. The cell of the non-striated muscle has no state of rest; but only the states of active and passive energy, during which it is busy in evolving and appropriating forces respectively. The termination of each state

seems automatically to serve as a stimulus, in response to which the cell enters upon the other. The phenomena of rhythm of a great many vital organs and organisms is due to the rhythmical function of this class of cells. Each kind of cell of this class has its peculiar period.

31. A part of the muscle cells of the heart and blood-vessels is of the rhythmical kind. We might also distinguish the two classes of cells as dependent and independent, because in the one its function depends upon an extrinsic stimulus, in the other it does not. If the independent function of the rhythmic cell is not clearly demonstrated by the phenomena of an excised heart in a vacuum, etc., we may appeal to the rhythmical phenomena of a great variety of vital unicellular organisms.¹ The functions of the rhythmic cells are of course greatly influenced by conditions, inasmuch as conditions influence their nutrition, temperature, etc.

¹ "On the Cause of the Rhythmic Motion of the Heart," James Paget, F. R. S., in *Proc. Roy. Soc.*, vol. viii, p. 473.

32. The muscular tissue of the heart and blood-vessels has, besides this property of rhythmic contraction, also the property of responding to an extrinsic stimulus. This indicates the presence of the dependent class of cells.

Professor Austin Flint, Jr., says: "It seems well established that the heart, although capable of independent action, is excited to contraction by the blood in its cavities." The heart, according to the same author, continues to contract in open air or vacuum, empty of blood, but feebly and irregularly; with water the contraction is stronger and more regular, with blood stronger still and most regular; that is, with blood in its cavities the heart acts about normally even when excised. Since all physiological processes are automatic, and never take place except in response to some event as a stimulus, and since there is no other event yet recognized that can be regarded as having such function, therefore the preceding considerations allow the inference that the dependent tissue of the heart contracts in response to blood pressure as a stimulus.

The independent tissue is evidently governed in the time of its contraction by the time of the contraction of the dependent, when the latter is in operation. The dependent does not seem to contract when the heart is excised and empty; for the weakness of the contraction when excised is reasonably explained by the absence of contraction of the dependent muscle-cells; and such dependent cells do contract when blood fills the heart cavities, for the contraction then is nearly normal. This class of dependent cells does not differ from those of the voluntary muscle; for we regard the blood pressure as affecting the nervous tissue of the heart, which then influences the dependent cell to contract. The important point for us is, *that blood pressure is the stimulus in response to which the contraction of the dependent muscular tissue of the heart takes place.* The independent tissue is none the less so on account of its slight dependence as to its times; its independence is evident from its contraction long after excision of the heart.

33. I have no doubt that the walls of the heart

and the muscular coats of the blood-vessels have functions very similar; they differ in degree, but perhaps not in kind. I doubt not that, so far as the muscular coat of the blood-vessel is concerned, and in proportion to the mass of it, we have the diastole and systole just as certainly and of the same kind as in the case of the heart itself. Dr. Henry Hartshorne's essays¹ on "The Arterial Circulation" and "The Present Condition of Vaso-motor Physiology" contain an abundance of overwhelming proof that the phenomena of arterial and venous pulsation are due in part to a rhythmic function of the muscular coats of these vessels analogous to that of the heart muscle itself; that these vessels have a diastole and systole; and that the arteries are functionally related to ventricles as ventricles to auricles and auricles to veins.

The human heart and large vessels are only differentiations of what is in primitive classes, and in embryos of higher classes of animals, a mere pulsating, valvular tube.

¹ Trans. Amer. Med. Asso., 1856 and 1872.

Essentially, the function of the heart does not differ from that of any section of artery or vein. What differences of detail there are, are due to differences of structure and differences of mass. This is an inference from the data of Dr. Henry Hartshorne's essay. It is also an inference from several obscure intimations that present themselves to the student of the anatomy and physiology of the blood-vascular system. What I have said in relation to the heart is intended only as ground upon which to assert the same in relation to the arteries and veins; especially that blood pressure is the stimulus in response to which contraction of the dependent muscular tissue of the vessel wall takes place.

34. The force of the systole varies directly as the degree of blood pressure in the heart. As this pressure, so far as its effect upon the inner heart surface is concerned, furnishes none of the force, but serves merely as a stimulus, we may call it the exciting stimulus. High tension in the heart, and therefore in the aorta, causes high tension in the coronary arteries. In this

state of things it may be that there is a more rapid and abundant supply of nutritive or force-yielding material to the heart muscle. If so, then either the force or frequency of the systole, or both, vary directly as the blood pressure in the coronary arteries. Independently of this, the force of the systole also varies directly as the degree of the exciting stimulus, and as the duration of the diastole. So far as I know, exceptions are only observed in abnormal conditions of health.

35. Pressure being withheld, as when heart is excised, contraction takes place and gives expression to the force that is liberated in the heart's tissue by the retrograde metamorphosis of that tissue or the material circulating through it. Leaving out of consideration the exciting stimulus (pressure), the contraction and its time are determined by the presence of the contracting force; and we may suppose that, the force present and available being $c+b+a$, only a is expended in the absence of the exciting stimulus. But $b+a$ is appropriated when the heart is

assisted by the ordinary exciting stimulus. Then, as the heart does still beat with greater force on the occasion of greater pressure, there must be a reserve supply of force generally, c , and in response to the greatest blood pressure all the available force ($c+b+a$) is appropriated.

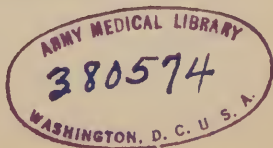
36. If I am correct so far, the variability of the length of diastole may be explained thus: Before a systole can take place, the force present and available must be $c+b+a$.

Without the exciting stimulus, the small amount of force a is consumed in the systole; the diastole is correspondingly short because it requires but a short time for the restoration of the force a . When in response to the ordinary degree of the exciting stimulus the force $b+a$ is consumed, the diastole is longer because it requires a longer time for the restoration of $b+a$. Similarly, when the systole is one of maximum force, $c+b+a$, the diastole is longest, because the longest time is required for the restoration of that amount of force. The quantities c , b ,

and α are collectively and severally variable on account of the variability of tension in the coronaries, as already explained, and on account of the variability of nutritive material in the blood, and on account of variability of mass of heart muscle.

The degree of blood pressure determining the degree of systolic force in the case of the heart, I assume the same to be the case in respect of the arteries and veins.

37. Whether the foregoing speculation be truth or not, there is a demonstrable probability of a certain very important item in the function of the muscular coats of the arteries and veins. This important detail is a variation of the lumen, which is dependent on the variation of blood pressure when the bodily act causing such variation is foreknown. It must be plain that blood pressure is nowhere constant. It is varied by position of the body, and evidently by sudden starts and stops. And the fact that, with all the violent motions of first and second classes that we voluntarily execute or submit to, there is no



such result as nausea, has induced me to conclude that when a motion is foreknown there is a vascular adjustment to compensate the tendency of the variation of pressure to produce a physiological disturbance.

I assume that the lumen of any given artery at any given section varies (in health) inversely as blood pressure at that section. So that the quantity of blood passing through that section is invariable, is independent of pressure or lumen; because the effect of greater pressure is counteracted by a smaller lumen, and a lesser pressure by a greater lumen. The blood pressure, when its cause is foreknown, serves as a stimulus in response to which the lumen contracts; pressure being relieved lumen again increases. If this is so (reasons will appear later), then there is no need of believing that there are two sets of vaso-motor nerves—one to contract, the other to dilate, the vessel. For if pressure is the stimulus in response to which alone contraction takes place, a decrease of pressure must

cause a dilatation, as an increase caused a contraction.

38. The variation of the lumen is undoubtedly accomplished through the agency of the vaso-motor nerves. There seem to be good reasons for believing that the vaso-motor system of nerves has an automatic and a volitional function.

The automatic function is performed by the fibres which originate in the sympathetic ganglia, and are afferent and efferent in respect of these ganglia. The volitional depends upon the vaso-motor nerves which are known to constitute a part of the cerebro-spinal system. In the case of the vascular adjustment which I have supposed to take place in response to a subjective determination to move or be moved, the vaso-motor nerves involved are the cerebro-spinal. These nerves, then, are evidently efferent, and their action in such cases is ideo-motor. But as the stimulus in response to which these nerves act must also often be at the periphery, in the vessel itself,

there must be a set of *afferent* nerves to convey the stimulating impulse to the vaso-motor centre.

The heart has such afferent fibres, known as vaso-inhibitory nerve fibres, or Ludwig's sensory nerve of the heart. The general law that an efferent nerve filament has somewhere a corresponding afferent nerve filament, would warrant the assumption of the existence of vaso-sensory nerve fibres. Such an assumption is also fully justified by the significance of an abundance of data furnished by experimental physiology.

I assume the existence of vaso-sensory nerve fibres, and hope in a separate paper (circumstances permitting) to give this assumption in the near future an elaborate support which in this work would be out of place.

39. I will use the expression *equilibrium of the circulation* to designate that uniformity of the circulation maintained during health, and which varies only in a manner consistent with local and general influences and needs.

Then I should say that this equilibrium is preserved by the agency of the vaso-motor nerves. As all motions tend mechanically to disturb this equilibrium, and as there is evidently no violence (to the animal) attending such motions when usual and of classes first or second, I conclude that the tendency to disturbance is compensated by a vascular adjustment, through the automatic or sympathetic vaso-motors, in the manner already explained. The sailor's immunity from sea-sickness is so explained. When an *unusual* motion of first or second class is undertaken, the cerebro-spinal vaso-motors are called into requisition to so adjust the vascular system as to counteract any tendency to vascular disturbance. Such adjustment is, of course, a muscular adjustment; it takes place simultaneously with any other muscular adjustments necessary to the motion undertaken; it takes place in response to the same subjective determination.

Any motion of third class disturbs the vascular system; because, on account of the mo-

tion not being foreknown, no adjustment can be made, neither volitionally nor automatically, to compensate the tendency to disturbance. Disturbances then occurring, they in some way serve as stimuli in response to which other disturbances take place; among these are nausea and all the symptoms of motion-sickness. These secondary disturbances are the first that the subject becomes conscious of.

40. It is quite clear that one must have a general comprehension of the motion to which he is subjected, as, for example, the motion of the horse he rides. It is, however, equally clear that, while he must know every *class* of movements that his horse executes, he need not know each *detail* of a class. For we all know that, being once accustomed to a horse's movements, we may actually sleep while travelling on his back and maintain all adjustments necessary to the erect position. And as all these movements during such sleep are harmonious with those of the horse, we evidently adjust automatically and unconsciously to movements

when familiar, which when novel required our attention to adjust to them.

Similarly at sea. The new sailor, being entirely unable to adjust to the ship's motion at first, soon learns to do so with the help of his attention to the motions; next he adjusts automatically and unconsciously. And our familiar example of sleeping on a horse in motion makes it easy to comprehend the possibility of adjusting to ship's motion in the much easier position of recumbency.

41. Facts and their circumstances have induced me to conclude that knowledge of motion is necessary in order to be able to compensate its tendency to vascular disturbance and consequent violence; that the compensation is effected at first by means of the cerebro-spinal vaso-motors simultaneously with all other muscular adjustments to the same motion; that finally the vascular and all other muscular adjustments are automatically and unconsciously executed, in which case I have supposed the vascular adjustments to be relegated to the sympathetic vaso-motors.

The theory that, when motions are foreknown, the variations of arterial pressure are compensated by inverse variations of arterial lumina, has grown out of a comparison of the circumstances, conditions, and results of third-class motions with those of first and second classes. When, for reasons, I had adopted this theory, there occurred to me a method by which I could certainly either verify or condemn it. If the theory is true, thought I, there must occur such an adjustment of the arteries of my head as to entirely compensate the tendency of gravity of blood to produce cerebral hyperæmia when I stand on my head. Otherwise the theory is false.

42. The experiment was tried, and resulted in notes as follows:—

San Francisco, February 27, 1884.—Placed a cane-seated armchair against a wall, put a cushion on it, and stood inverted with my head on this and heels against the wall. I stood quite comfortably, without the slightest signs of cerebral congestion, either subjective or objec-

tive, until the tenth minute had been completed. Then early in the eleventh minute there appeared some sensible subjective evidence of cerebral congestion. At twelve and one-half minutes a competent assistant, who kept the time, observing sclera and anterior temporal arteries, found slight but undoubted indications of congestion. The subjective symptoms were also yet slight at this time. At full thirteen minutes, while the signs of congestion were still slight but undoubted, the experiment voluntarily terminated. In a few moments the discomfort almost entirely subsided, but not completely for thirty-six hours. It was quite reasonable to suppose that these symptoms of congestion were induced on the principle of counter-irritation by the somewhat painful pressure of my weight on the top of my head.

The experiment was therefore tried again, September 20, 1884, in the office and presence of Professor W. F. McNutt, who kindly consented to be the observer. I stood with my shoulders on two chairs, head down between them and

heels up against the wall. During the latter part of the tenth minute there appeared the sensation of tension in my head; it became gradually more intense. At the end of the fifteenth minute I got down, and during five or six seconds felt the merest dizziness. During the fifteenth minute anterior temporal arteries were observed to be distended and conspicuous, pupils were dilated, sclera were congested. Immediately after getting down the eyes were more closely observed, and the conjunctival parts of sclera and lids showed an active injection of all the finer vessels, the pupils normal, pulse soft and seventy-two.

The sensation of discomfort almost entirely disappeared in a minute, there was the merest trace of it at ten P.M., and nothing left of it next morning. From these results I conclude that during a voluntary inversion of about ten minutes there is maintained by the vaso-motors such an adjustment of the vascular apparatus as compensates the gravitation tendency of blood to the head; and that on account of the parts

involved being subjected to unusual service the nervous (or muscular) energy required to maintain this compensating adjustment is exhausted in about ten minutes, after which cerebral hyperæmia takes place.

44. The importance of such adjustment may be more vividly realized by remembering that the pressure of blood in the brain arteries in the upright position is that transmitted from the heart *minus* a certain gravitation tendency of blood from head to heart. In the inverted position that pressure is that transmitted from the heart *plus* the gravitation tendency of blood from feet to head. Consequently, if hydrostatic principles hold true for blood in its vessels, the arterial pressure in the brain in the inverted position exceeds that in the upright position by twice the gravitation tendency of blood from head to heart *plus* that from feet to heart.

45. Other things equal, passengers suffer far less violence from ship's motion in the recumbent than in the standing or sitting positions. If my theories so far are true, this is as it

should be; and the theory of vascular disturbance receives a further item of confirmation by the explanation next to be given. Bearing in mind that gravity and inertia are the agents on which vascular disturbances depend, and that the fluid columns cannot be disturbed by these forces except when they (the forces) act on the columns in the direction of their length, it follows that either of these forces acting on the body perpendicularly to its long axis will cause a very much less vascular disturbance than when acting in the direction of that axis. Because the sum of the longitudinal vessels is much greater than the sum of vessels at right angles to the long axis in any given plane. While the ship's motions are very numerous, the resultant of them all operates on the body as a single force at any given moment.

Whatever the direction of application of such force to the vascular system, it will disturb the contents of those vessels mostly that lie in that direction, and will also disturb the contents of those vessels that lie within the range of less

than ninety degrees of such direction; the disturbance being slight in vessels lying at angles greater than forty-five degrees from the direction of the disturbing force. Prominent in the resultant of the ship's motion is the up-and-down constituent. While standing or sitting, this factor operates in the direct line of the long axis of the person. While recumbent it operates at right angles to the long axis, and in only one plane at any given moment. Consequently in recumbency there is much less vascular disturbance possible than in the erect position.

Another reason why one is sicker in the erect than in the recumbent position is given in the discussion of cerebral anæmia as a symptom of sea-sickness (§ 88).

46. The causation of optical vertigo is a prominent factor in the causation of sea-sickness. And inasmuch as this factor is dependent upon *motions*, either of the person or his environs, it comes properly within the limits of this chapter and accordingly will be here considered.

We have seen how mathematically accurate

are our intuitions of space as exemplified in the accurate muscular adjustments involving space, even though such space cannot by subject be expressed in conventional terms. And we also know how accurate is the intuition of location in space as exemplified in the ability of the woodchopper to strike his axe in the same place repeatedly; his stroke being swift, strong, and through a distance much greater than the chopper's height. And all with little or no deliberation apparently, and with the unaided eye. It is easy then to see that one's intuition of distances of walls, ceilings, and floors of his room are accurate. It is one of our habitual expectations that the walls, ceilings, and floors of our rooms remain in invariable positions; that any variations of their distances are due to our own movements. Now any change of a wall's distance, or other variation of its position, not due to our own movements, constitutes a result realized differing from a result habitually expected. It therefore constitutes a disappointment, and serves as a stimulus in response to which some

kind of physiological violence takes place. One disturbance institutes another, and somewhere in the series of events occur those of which alone we become conscious. These are the vertigo, nausea, vomiting, and other items in a more or less general illness. Not only does every variation of distance constitute a disappointment, but so does also every observed movement of an object which should according to our habitual expectation, remain immovable. It is scarcely necessary to add that the resulting illness represents an accumulated violence.

47. Thus we explain optical vertigo as it occurs on the ship at sea. It affects the person in any part of the ship. The effect is exaggerated by movements of fluids in vessels, and the oscillations of clothing suspended from hooks, both being violations of the habitual expectation that such things in *rooms* remain quiet. In a similar way I would explain the optical vertigo consequent on the observation of unexpected relations, momentary or continued, among our environs and between them and ourselves, whether

such relations be real or are made apparent by an unusual modification of our usual means of vision. Thus, I am assured by Dr. George H. Powers¹ that it is a certainty that violence may result to the person through the sense of sight; that persons often get sick — nauseated — by putting on ill-suited spectacles for the first time, and by leaving off spectacles when accustomed to them; that in these cases all other sources of physiological violence are certainly excluded.

48. I have become dizzy by attempting to read the inscriptions on the cars of a passing freight train when I was riding on another train in a contrary direction. In such cases I generally failed to make out what the inscriptions were; so that in the case of a single train I made a series of attempts, and nearly as many failures and experienced an equal number of disappointments, each resulting in violence the sum of which amounted to the conscious illness which caused me to cease the efforts. One of the first

¹ Professor of ophthalmology and otology in the University of California.

things to be observed in such a panorama as we have now in San Francisco, on the corner of Mason and Eddy Streets, is that the transition from the platform upon which we stand to the scenes upon which we look is so gradual that it is difficult or impossible to *see* where the one ends and the other begins. And to see this is what almost all visitors attempt, and many of them soon become vertigoed and even nauseated. Here again by way of explanation we have only to note the series of attempts to do a difficult thing, a series of failures, and consequently disappointments, each of which latter resulting in violence the accumulated sum of these amounts to the illness that terminates the series of fruitless efforts.

49. It sometimes happens that, when motion is observed in an object which we habitually believe to be fixed, we interpret the phenomenon as due to our own movement, and have, in fact, subjective sensations of motion in such cases which are attended with all the consequences *that* follow objective sensations of motion of the

same kind. That is to say, there occurs then the appropriate vascular adjustment to that motion. But there being no motion of the person, the vascular adjustment amounts really to a vascular disturbance; and this case of adjustment without motion is equal to the case of motion without adjustment. And the illness, seeming to be optical vertigo, is really due to vascular disturbance complicated with the effect of disappointment incidental to the unexpectedness of the event.

50. By similar reasoning I explain the class of cases typified by the following two, which were related to me by personal friends. Mrs. C., some weeks after crossing the Atlantic and being very sea-sick on the voyage, stood by the Bay of Naples. A sudden change of weather caused the bay to become rough while she was looking at it, whereupon Mrs. C. became decidedly sea-sick. Colonel S. had been at sea considerably, and sea-sick. On one occasion while he stood on the sea-wall at San Francisco a sudden change of weather caused the bay to become

rough while he was looking at it. He became so vertigoed as to be obliged to withdraw from the scene. In general, the subjects of such experience have been at sea. While on ship they learned that the rising and sinking of the sea was mostly apparent, and that the rising and sinking of the ship and of themselves was real. Motions of the sea were, as a matter of habit, associated with motions of themselves and the appropriate sensations of such motions. Afterwards, standing on shore and watching the swell rise and fall, the observer, by virtue of habit acquired on ship, automatically and unconsciously associates motion of himself with that of the swell. But his sensation of motion is subjective, and the adjustments, vascular and muscular, really amount to vascular and muscular disturbances, as already explained.

51. Another class of cases should be mentioned here, not because it is included with the subject of optical vertigo, but because it is generally included with the class just explained. It is a distinct class, however, and in no way

related to the preceeding, and has not a particle of optical vertigo in it.

A lady, who several times each year made a trip by sea to a port one hundred miles distant, assured me that she always got slightly but decidedly sea-sick while packing up preparatory to the trip. I have been told of two other like cases. I always got slightly sea-sick during the three or four hours prior to departure of the ship, excepting the first departure. Early in the year there was some anxiety incidental to preparation for the trip, and I thought the sickness was in some way due to it. But when it had become a common thing to depart, with no reluctance nor anxiety about it, I still experienced that nausea during the several hours prior to sailing.

While writing on the symptoms of sea-sickness, I have several times been so vividly reminded of sea-sick experiences that I was slightly but undoubtedly nauseated. A variety of other cases involve the same principle, are of the same class, and assist in making the above

more pertinent cases interesting and intelligible.

Thus, the late Dr. W. B. Carpenter wrote:¹
“Van Swieten relates of himself, that having chanced to pass a spot where the bursting of the dead body of a dog produced such a stench as made him vomit, on passing the same spot *some years afterwards* he was so vividly affected by the recollection, that the sickness and even vomiting recurred.” The same writer continues:
“So it must be within the experience of everyone, that tears rise at some painful or tender reminiscence; that the mental reproduction of circumstances which originally produced a blush of shame or self-consciousness, will call forth not merely the same emotion, but the same expression of it; and that laughter is as often provoked by the remembrance of some ludicrous incident, as it is by its actual occurrence.”

52. The brain records impressions of sea-sickness which serve for purposes of recollection. When these impressions are by recollection reproduced to consciousness, they may in turn,

¹ “Mental Physiology,” 4th Edition, p. 432.

under peculiar circumstances, reproduce the very state of things which they represent.

The preceding statement purposely comprehends two possible meanings. By *state of things* I mean either (*a*), — the group of sensations that is experienced in sea-sickness, or (*b*), — the group of symptoms that constitutes sea-sickness. If the view (*a*) be the true one, then the reproduced sea-sickness (§51) would be a group of subjective sensations, hallucinations, and the person would not be sick at all. If the view (*b*) is correct, then the person is really sick, and the case presents the following phenomena: The reproduced impressions of former sea-sick sensations emerge into consciousness and serve as stimuli in response to which efferent nervous impulses go out to those parts of the body involved and cause them to assume abnormal functions and conditions as in sea-sickness; the abnormal functions and conditions again serve as stimuli in response to which nervous afferent impulses emerge into consciousness as the real objective sensations by which the person is

aware that he is sick. It is likely that there is a succession of events that may occur during consciousness but not during unconsciousness, each serving as a stimulus in response to which the next takes place, and that the aggregate conscious effect is the offensive group of sensations. I take the view (*b*) as the correct one, because the reproduced states often embrace symptoms which cannot be attributed to mere hallucinations, and because it accords with the only view that I know of, which will explain exemption from sea-sickness in those several states of the person in which activity of consciousness is more or less subsided (§ 59).

53. Optical vertigo is a variable quantity in the constitution of sea-sickness. With some it is the chief item. This is the case with a distinguished American naturalist who on a late voyage told me that his sea-sickness almost subsides and he can get about the deck quite well when night comes on. To exclude optical vertigo the eyes, of course, are to be kept closed.

Some have regarded sea-sickness as consisting entirely of optical vertigo, asserting that blind persons do not get sea-sick. Instances enough of blind persons getting sea-sick are, however, cited in the literature of the subject; and I have made the subject a matter of personal inquiry of ship officers and at two institutions for the blind. I find that blind persons do get decidedly sea-sick.

54. There is probably not a class of ills known to doctors from which there are not some persons exempt, even when subjected to the severest tests. About one in two hundred of the human family are exempt from sea-sickness. This includes those only who are in good health and not sick when for the first time on the sea and subjected to the severest test for a sufficient length of time. This one in two hundred does not include young children. Any illness, however slight and in whatsoever way manifested to the subject, if it supervene in consequence of subjection to third class motion, or any condition present on and peculiar to the ship, is sea-sick-

ness. Vomiting is not an essential symptom. If now the etiology of sea-sickness were as lucid as that of any other disease, I might still be excusable for failing to account for these exemptions inasmuch as they are not accounted for in respect of any other disease.

That severally and collectively the factors in the causation of sea-sickness produce different effects on different persons at the same time, and different effects on the same person at different times, is not more mysterious than the similar behavior of the causes of many other diseases, or the similar variability of drug effects.

Personally I have not been able to familiarize myself with a sufficient number of these exemptions to see if there is anything in their constitution by which to account for their exemption.

In the sequence of events which begins with motion and ends with sickness an essential item, we have seen, is a disappointment. Some exemptions, whose mental constitutions I have attempted to scrutinize, have told me that they do

not suffer violence even from such mental effects as are incidental to violent misfortunes. If in these cases there is no disappointment with its consequent violence, because there is no fixedness of expectations, or for other reasons, and this peculiarity of the individual is for him general, then the cause of his exemption is obvious.

55. Besides these exempts of normal condition there are several classes of exempts of abnormal condition. These are: many deaf mutes, persons in the trance state, subjects of *delirium tremens*, and insane folks.¹

It has been and is still believed by some, that some kind of disturbance of the semicircular canals of the internal ear is essential to seasickness. Professor William James says:² "It occurred to me that deaf-mute asylums ought to offer some corroboration of the theory in question if a true one. Among their inmates must certainly be a considerable number in whom

¹ The reliability of this statement depends upon the correctness of data of other observers.

² Am. Jour. Otology, Vol. 4. No. 4, p. 239.

either the labyrinths or the auditory nerves in their totality have been destroyed by the same causes that produced the deafness. We ought therefore to expect, if the semicircular canals be really the starting points of the sensation of dizziness, to find on examining a large number of deaf mutes, a certain proportion of them who are completely insusceptible of that affection, and others who enjoy immunity in a less complete degree. The number of deaf mutes who have been examined to test this suggestion is in all five hundred and nineteen. Of these, one hundred and eighty-six are reported as totally insusceptible of being made dizzy by whirling rapidly round with the head in any position whatever. Nearly two hundred students and instructors in Harvard College were examined for purposes of comparison, and but a single one remained exempt from vertigo. Of the deaf mutes, one hundred and thirty-four are set down as dizzy in a very slight degree; while one hundred and ninety-nine were normally, and in a few cases abnormally sensitive. The sur-

mise with which I started is thus proved, and the theory that the semicircular canals are organs of equilibrium receives renewed corroboration.

“That changes of intra-cranial pressure will give rise to dizziness by directly influencing the brain independently of the semicircular canals is evident from the number of subjects who are of reduced sensibility as respects dizziness from whirling, but who say that they feel dizzy when their head is suddenly raised from a bent position, or when they get up after stooping to the ground. In reply to the question, ‘Do you ever experience dizziness under any other circumstances (than whirling)?’ Two of the ‘not dizzy’ class, six of the ‘slightly dizzy’ class, and five of the ‘dizzy’ class speak of experiencing this feeling. Fifteen of the not-dizzy or scarcely-dizzy classes had been at sea, and of these not one had been sea-sick. This fact affords a presumption that non-dizzy deaf mutes may, *ipso facto*, enjoy immunity from sea-sickness. This, it is true, is negative evidence, and

might easily be upset by two or three cases of exemption from dizziness with susceptibility to sea-sickness. I have three such possible counter-cases, but, in all, the record is so imperfect (and no address being given further inquiry cannot be made) that they cannot be used."

56. Professor James's subject has been and will probably continue to be a fruitful one. Those, however, who are unacquainted with his methods of obtaining the data may well doubt the reliability of many answers to questions that are propounded mediately and distantly to students of deaf-mute educational institutions. I very much doubt the reliability of information got in that way from such a source. Reliability as any other educational result, is in the deaf mute's case a thing of tardy development on account of the greatly restricted access to his mind. From ten chief stewards of passenger steamships, I obtained, personally and in writing, ten sets of answers to the same eighty questions propounded to all for the purpose of obtaining data for the study of sea-sickness.

By various other means and by later personal experience I have found that some of these stewards gave me a considerable share of what seem to me to be purposely erroneous answers. Information got in this way *alone* is useless for scientific purposes, and more so must be that which comes from deaf-mute minors.

57. "In ordinary life the sense of what is the vertical is never lost. A certain number of non-dizzy deaf mutes when plunged under water seem to be affected by an indescribable alarm and bewilderment, which only ceases when they find their heads above the surface."

Professor James very naturally infers from this, that the ordinary individual when under water and relieved of the sensible traction of gravitation is still cognizant of the vertical by means of his semicircular canals of which the non-dizzy deaf mute is supposed to be deprived. So far as I know, this item, in Professor James's very interesting paper, is the strongest support which the semicircular-canal theory of sea-sickness has.

Baginski¹ has thrown much doubt on the inferences from the results of the numerous vivisection experiments on the semicircular canals.

After much careful study of the semicircular-canal theory of sea-sickness, I am obliged to disclaim any confidence in it.

58. The late Dr. George M. Beard determined² that when persons are put into the trance they are entirely exempt (when restored to consciousness) from the dizziness and nausea that ordinarily results from such tests as those to which Prof. James subjected the two hundred Harvard students. Dr. Beard said: "I have no doubt whatever that sea-sickness could be cured entirely by putting persons into trance." The experiment had been put to practical tests by a New York clergyman who met with apparent success on ship-board before the date of Dr. Beard's experiments.

According to the theories already offered it must have been observed that the primary disturbance from which motion-sickness proceeds is *peripheral*, and that this peripheral disturb-

¹ Am. Jour. Otology, Vol. 4, No. 1, p. 51.

² Am. Jour. Otology, Vol. 4, No. 4, p. 253.

ance gives rise to an impulse which is transmitted along the vaso-sensory nerves to the vaso-motor center and there serves as a stimulus in response to which there occurs a series of events, the final of which are those symptoms which when they emerge into consciousness prove to the patient that he is sick. Not only must the primary disturbance give rise to an afferent impulse, but it requires a variety of other afferent impulses to make us conscious that we are sea-sick. And I scarcely doubt that the earlier afferent impulses emerging into and affecting consciousness serve as stimuli in response to which one's share of sea-sickness is increased greatly beyond what it would be if such earlier impulses did not thus set up a continuation in the evolution of the sea-sick phenomena.

59. It is a distinguishing peculiarity of the trance state that *peripheral impressions do not emerge into consciousness*. Motor activity in the trance state is always ideo-motor and never sensori-motor. The suggestion of the operator

never emerges into the consciousness of the subject; but it serves as a stimulus in response to which a subjective sensation or group of sensations emerges into consciousness. And this group of subjectives is followed by all the consequences that would attend a similar set of objectives. For example, subject is told to drink vinegar; a glass of water is put to his lips. The appearance assumed by his face is that which properly associates itself with drinking vinegar, but as he is only drinking water, it is plain that the gustatory sensation of vinegar is subjective, evolved into consciousness in response to the suggestion, but neither the suggestion nor the gustatory sensation of water emerged into consciousness. This view is entirely consistent with all the trance phenomena; a farther showing, I think, would be superfluous. I will just mention another case, however, which is typical and interesting on account of its familiarity and because it shows how similar are the dream and trance states and activities.

Our case is a type of a class of dreams. Many of us have once or oftener had a dream in which there was a gun-shot report associated with an appropriate group of subjective sensations, such as could have had their origin in the oft repeated impressions of a class of newspaper items.

The dream seeming elaborate is, however, short and is followed by awakening; *then* the real objective character of the shot emerges into consciousness for the first time. The shot of the dream and the group with which it was associated were all subjective. The objective impression reached the brain, of course, but the subjectives evolved by it reached consciousness, while the objective impression was detained somewhere short of consciousness until the subject had awakened.

As in these dreams so in the trance state, objective impressions do not emerge into consciousness, but may serve as stimuli in response to which subjective sensations emerge into consciousness.

Accordingly, as a person in the trance state cannot be made sick by motions of class third, I conclude that it is because the seat of consciousness, and possibly other brain centers, are in the trance state closed to objective impressions.

60. There is another way of accounting for exemption from sea-sickness in the trance state which seems rational. Experimental physiology teaches us that as functional activity of the cerebrum is decreased, to the same extent (within limits) will the functional activity of the nerve centers elsewhere be increased. In other words, the functions of the cerebrum being suspended, other centers assume their maximum of functional activity. The cerebrum, we are taught, has an inhibitory influence over other nerve centers; therefore when the cerebrum is inactive, the other centers of brain and cord enjoy the maximum functional efficiency; that is, the animal is then as automatic as his constitution admits him to be. In the trance state the subject is in the highest possible degree

automatic. And if we suppose that the excitomotor functional efficiency of the nervous structures concerned is such that new, unusual and complicated motions are perfectly adjusted to in this automatic state of the subject, we have a second explanation of the trance subject's exemption from the violence of third-class motions.

61. Whether or not the subject of *delirium tremens* is an exempt, is a question. R. M. Bache, in American Journal of Science, mentions two cases at sea for the first time and not seasick. If the constitutional disturbance from which the person already suffers be increased by the amount of disturbance incidental to a moderate degree of sea-sickness, it might be difficult to observe that any part of the general violence consisted of sea-sickness. But Mr. Bache's observation was probably correct. And the intelligence is not surprising after we learn of the exemption of persons in the trance state. The conditions of trance and *delirium tremens* have much in common. In *delirium tremens* there is

no volition. Attention is not volitional but automatic and appears to me to be directed almost exclusively to subjective sensations or groups of them. It may seem that the attention is also engaged largely upon illusions (confusions of objective with subjective sensations or groups) but, until I see more evidence in favor of this, I shall believe that the objective impressions do not emerge into consciousness as sensations, but only serve as stimuli in response to which the subjectives are evolved into consciousness.

According to this view of the case, the exemption from sea-sickness of the subject of *delirium tremens* is to be explained precisely as I have explained the exemption of the subject in the trance state. Another explanation of exemption in this case is similar to the second explanation of exemption of the trance subject. A person in *delirium tremens* is absolutely automatic.

62. Bache mentions a case of an insane girl at sea for the first time and not sea-sick. A writer in "All the Year Round" says: "Crazy

folk are reputed to defy the stomach searching movements of the sea. Physicians who have tried the experiment, in the hope of curing a crack-brained patient, have brought horrible sufferings on themselves, while their invalids enjoyed perfect ease and comfort."

A chief steward¹ of a steamship said to me : "Crazy people never get sea sick ; carried lots of them." Another chief steward² said that he had carried eight that he recollects, none of whom were sea-sick.

The explanation of their exemption is similar to that given for subjects of trance and *delirium tremens*. The attention of the lunatic is automatic and is directed to subjective sensations, his objective impressions do not as such emerge into consciousness. And the second explanation given for exemption in the preceding cases applies to lunatics also. The lunatic is absolutely automatic.

63. "Sea-sickness but rarely affects the extremes of life — infancy and old age." — Beard.

¹ C. K. James.

² O. N. Clark.

Captain R. P. Manson, in a letter to R. M. Bache,¹ dated at Bath, Maine, October 14, 1861, says: He has been thirty years in actual service as ship master, mostly in the European business, and has never known a nursing infant sea-sick. That children two and one-half to four or five years of age are not often sea-sick; when so, the attack is short, slight, and rarely returns. That this is what he has invariably observed with many hundreds of emigrant families.

The testimony of others and of myself agrees with that of Captain Manson so far as ordinary ocean travelling is concerned. But I have good and sufficient testimony to show that on the small steamships plying on the channels between the Hawaiian Islands a great many young children *do* get sea-sick. And from that testimony I would infer that they get sea-sick also under like circumstances and conditions on small steamships on any other ocean channels.

A very intelligent lady friend who resided

¹ Am. Jour. Sci. Vol. 34, p. 17.

two years at Honolulu and made several inter-island voyages, and whom I consider a good observer and undoubtedly good authority on this point, told me that it is common for babies to be sea-sick on the inter-island voyages. The same intelligence was expressed to me two years later by other residents on the Hawaiian Islands; among them Captain Lorenz of "Wild-er's Steamship Company," a personal friend in whose testimony I place absolute confidence. Captain Lorenz says that on the inter-island channels about thirty per cent. of nursing infants are sea-sick, but for a very short time, often only a few minutes, as judged by the duration of the paroxysm of vomiting. Special cases were pointed out to me.

One was an infant sea-sick at the age of three months; another in the same family sea-sick at the age of eight months; the same again sea-sick at the age of two and one-half years. These belong to an unusually susceptible family with whom I am personally acquainted.

Since its earliest existence in embryo, and until

its mental development has become such that it can comprehend the nature and details of movements, and until it can execute movements of its own determination, the child has been subjected to movements that belong properly to class second. These movements have been passive bodily; and, inasmuch as they have been consented¹ to, though unconsciously, they were active mentally.²

There seems at first sight some difficulty in regarding these movements as active mentally. But this is only apparent, since neither consciousness nor even mind, however rudimentary in development, is necessarily involved in second-class motions. It is only necessary that there be a nervous mechanism which operates automatically in response to appropriate stimuli.

¹ The animal in embryo *consents* to movements as a stone or stick consents to movements. We may say they *consent*, because they do not *resist*; resistance being the normal response to passive movements in organisms having a considerable nervous development.

² This word, apparently in irrational use here, is retained to preserve, for cases here considered in which mind is *not* involved, the distinctions between classes of motions when mind *is* involved.

This seems quite reasonable when we remember that the distinction between motions of second and third class holds clearly true in respect of aquatic birds.

And our familiar examples of adjusting to motions during sleep, on ship in recumbency, on horseback in erect position, and in other situations and circumstances, further demonstrate that nothing more than an automatic nervous mechanism is necessary to adjust to motions that are passive bodily. Motion being fore-known, adjustment automatically and unconsciously follows. Adjustment consists of ideomotor, muscular action. The motion becoming frequent, the ideomotor adjustment becomes habitual. But on the part of the infant, adaptation to motion was begun with its earliest vital existence in embryo, and with the most rudimentary nervous mechanism. This therefore is a case of adaptation without any foreknowledge of the motion whatever. This instance, and the fact of adaptation of lower animals to passive motions, and the fact of our

adaptation to ship's motion while sick, asleep, or under drug influence, in all which cases mind seems not to have had any part in the adaptation, all show that merely a nervous mechanism is the essential thing to institute the muscular adaptation. But we must not forget that mind, when in operation, very greatly facilitates adaptation. The small stock of available mental force is, however, too soon exhausted to be of practical use, as will be shown elsewhere.

64. Motions of the second class, then, have been the rule with the infant. We must now bear in mind the nature of the motion to which the child has been subjected *in utero* and afterwards until it has become independent in locomotion. Of this motion we must bear in mind the nature of the details, what variations and their frequency and abruptness, what amplitudes and violence of movements, what velocities, what aggregate amount of movements and of variations in given times. He that bears in mind these details of the average case of the kind under consideration, and has a correct and

experimental idea of the motions of large vessels in the broad, open ocean, and has an equally good idea of the motions of small vessels in limited channels of the sea will probably agree with me that the passive motions of the infant, pre-natal and post-natal, are more violent and complicated than the ordinary motions of the large ships on the open sea, and less violent and complicated than the motions of the small vessels on the confined seas.

Now since second-class motions have been the rule with the infant, we should *expect* to find what is really the case, namely, that when subjected to the more gentle motions of a large, steady ship out on the open sea, the infant does not get sea-sick, because it is the habit of its vaso-nervous mechanism to adjust to motions of that class.

And on the other hand we should *also* expect to find what is *also* really the case, namely, that when subjected to the more *violent* motions of a small vessel on an ocean *channel*, the infant *does* get sea-sick, because it is *not* the habit of its

vaso-nervous mechanism to adjust to motions so *violent*.

65. This vaso-nervous adjusting habit being constitutional, it remains efficient and operative for some time after the child begins to execute movements of its own determination. It is during this time that it enjoys immunity from sea-sickness under the circumstances observed by Captain Manson. And again, as the vaso-nervous adjusting habit is the more readily revived as the time elapsed since its operation is short, we can easily understand why the liability to sea-sickness is increased as the child's age is advanced. It is, perhaps, proper here to express the opinion that getting used to the ship's motions on the part of the adult, consists in a restoration of the operation of the constitutional, vaso-nervous adjusting habit of the child. And that the greater difficulty of getting used to the violent motions incidental to stormy weather, and ordinarily to channel navigation, is consistent with the belief that for this purpose the vaso-nervous adjusting habit of the

child has not only to be restored, but must be amplified to a great extent, and that to such an extent it is really an acquisition of a new habit. And a very difficult habit it is to acquire, as we may judge by the number who cannot get used to such violent motions.

66. The child's exemption from motion-sickness due to vascular disturbance seems thus far explained. So far as motion-sickness is attributable to disappointment, the child's exemption is explained by the fact that it has few expectations and but little fixedness of these few expectations, and is for these reasons but little liable to disappointment, and therefore nearly free from the causes of optical vertigo. Again, young children cannot make accurate muscular adjustments; for their adjustments are not based on correct intuitions of space and weight. Correct intuitions, depending as they do upon experience, are not yet acquired. Muscular adjustments of young children are at first tentative. Disturbances of muscular adjustment are therefore not disappointing to them. They are the rule.

67. Dr. Beard stated that sea-sickness but rarely affects old age—above sixty. Observation and inquiry compel me to differ from him. Nausea and vomiting are not necessarily present in sea-sickness. Very often in the absence of these symptoms the patient is supposed by himself and others not to be sea-sick, when at the same time he suffers from one or more of about a dozen ways in which sea-sickness may manifest itself. Many persons do not confess to being sea-sick unless they are *considerably* so, or unless their illness is so clearly evident to the observer that denial is useless. At sea we hear passengers say: “I am not *sea-sick*, but my stomach is out of order.” “*I* am not sea-sick, but have a slight headache.” “I am *not* sea-sick, but feel stupid, sleepy; find it difficult to read and impossible to think.” Drawing a line between the ill and the well, we must, with strict regard for the truth, put all such as the above cases on the ill side of the line.

CHAPTER II.

IMPURE AIR IN THE CAUSATION OF SEA-SICKNESS.

68. It is the testimony of many who travel on the ferry steamers which make a run of several miles across the Bay of San Francisco, that they may sit inside the cabin (often crowded) when the bay is smooth, but get sick inside when the bay is rough. And under no circumstances do they get sea-sick on the outside. The ventilation of the cabins of these boats is made as good as practicable by some of the doors being left open. But it often happens in cool weather that some persons, suspicious of draughts more than of air worse than second-hand, close some of the doors.

The company ought not to allow ignorant in-

dividuals to interfere with so important a matter as the ventilation of a room, in which there are five hundred or more passengers. However, as many individuals may remain in the cabin and breathe very impure air and not get sick when the bay is smooth, it is certain that such air is not alone sufficient to make them sick during the length of time exposed to it. And as such persons may remain outside, when the bay is rough, and not get sick, it is certain that the boat's motion is not alone sufficient to make them sick. But as these people get sick in the cabin when the bay is rough, it is certain that the *combined* effects of impure air and motion *are* sufficient to make them sick. Being subjected to the effect of one, a person is rendered very sensitive to the additional effect of the other—to what in health would be no cause of gastric provocation.

69. That nausea (similar to sea-sickness) which many have suffered in railway cars is due to the combined effects of third-class motion and second-hand air. Railway cars, on the Pacific

Coast, at least, even when only half full, **are not** sufficiently well ventilated, as a rule.

A ship officer told me that it sometimes happens that a person is sick in a railway car going to a port at which he takes passage on a ship, and then is not sea-sick on the ship. I suspect that in such cases the persons availed themselves of pure air on the ship, and the motions alone were not enough to make them sick; whereas in the cars they were subjected both to motions and foul air. It is easy then to understand why many ocean passengers not yet sick will suddenly become so on the "companion way" down to the saloon to meals, etc. In such cases, however, the whole effect must not be attributed to the slightly impure air and odors of the saloon with its food-laden tables. To do so would be unjust to the ship's management. The sudden and effectual precipitation on the "companion way" is without doubt due in part to the nauseating effects of the several physiological disturbances that occur to those who do the unusual thing of going down a set of stairs

(partly spiral) that are unsteady. Dr. Beard mentioned the case of a friend, sick an entire year at sea, who could not afterwards enter any place where the air was foul, without feeling the symptoms of sea-sickness come upon him. Such idiosyncrasies in respect of second-hand air are not rare.

70. In large cities, where and when the temperature is such that offices, work-rooms and residences are kept closed for the sake of the comfort of occupants, there are a great many who not only habitually breathe second-hand air, but who have acquired an adaptation to it. This adaptation, however, is only apparent. The evils consequent on breathing impure air, when the subject is adapted to it, do not appear as sudden and acute violence, as is the case when a sudden, considerable, and persistent change is made from pure to impure, or from impure to impurer air. Instances of violence in consequence of these sudden changes will be cited later.

The violence suffered by those who are used

to foul air shows itself in general inferiority of health, in general susceptibility to disease, in special susceptibility to "colds" and therefore to consumption.

Second-hand air contains excreted filth. Whatever the attenuation and smallness of the dose, the advantage of this is lost by the large number of doses taken.

71. The air space of an ordinary cabin on a ship is so small that any ventilation short of a constant current of fresh air through the room from without is insufficient even for one person, much more so for the two occupants that the room is designed to accommodate. Such limitation of space is, of course, a necessity. And when air becomes second-hand or worse because the ship is necessarily much closed up in stormy weather, no one can be blamed. But there is still a large percentage of the first-class passenger list who neglect or refuse, even when well, to appropriate pure air when easily available.

Dr. William S. Wilson¹ says: "Whatever the

¹ "The Ocean as a Health Resort."

modus operandi of the cause of sea-sickness, the fact remains that the open air is wonderfully beneficial, and advantage should be taken of the first symptoms of returning energy, and the first interval of fine weather, to go on deck." Instead of attributing good effects to pure air outside, as Dr. Wilson, and everyone who is heard from on this subject does, I should rather attribute the *ill-effects* to the *impure* air of the *cabin*. If a patient recovers from his illness by going into pure air, it is generally because he has withdrawn from the influence of the *cause* of his illness, impure air. The much greater prevalence of sea-sickness during stormy weather is very largely due to impure air; because the weather and sea are such that many openings ordinarily used for ventilating purposes must be closed, lest the interior of the ship be drenched and swamped by the water that would otherwise enter by tons at a time.

72. From "An Analysis of Ship Air and its Effects,"¹ we learn that seamen as a body are

¹ In the "Medico Chirurgical Transactions," London, Vol 56, (1873), by Alexander Rattray, M. D., Edinburgh.

neither healthy nor long-lived, but the reverse. This is proved, first by their low average age, said to be thirty-three, evidently too brief² for men who are carefully selected and subsequently kept under the most approved hygienic influences; and second, by their sick and death rates being equal to those of landsmen, who include the two periods which contribute most to both lists, namely, infancy and old age. This indicates subjection to certain unhealthy agencies, of which impure air is evidently one, and perhaps the most powerful.

During the three years 1867-8-9, taken at random, there were selected for H. M.'s Navy 50,347 strong and healthy men. Among whom there occurred annually for these three years 6,796 cases of catarrh and other inflammatory lung diseases, and 392 cases of morbus cordis. There occur in H. M.'s Navy 384 cases of scrofula annually.

On the wooden, screw frigate, Bristol, ventilated chiefly on the old windsail plan, and a

² Refers to longevity of British naval marines.

fair representative ship, Dr. Rattray, on a voyage of four months (July to November, 1871), from the Cape of Good Hope to England, determined the presence, in ship air, of impurities of animal, vegetable, and mineral origin, which comprised odorous and inodorous gases, vapors, and solids, all more or less unhealthy, and derived:—

First and chiefly,—carbonic acid, ammonia, sulphuretted hydrogen, volatile organic matter, vapor of water, etc., derived from skin, lungs, etc., of the crew.

Second, from the ship,—organic and inorganic odors, and minute particles of wood, paint, cordage, whitewash, leather, iron, zinc, copper, etc.; from the bilge and lining,—ammonia, ammoniac sulphide, sulphuretted hydrogen, and occasionally microscopic animal and vegetable organisms.

Third, from the stores,—particles of bread, cotton, wool, etc.; from the slow combustion of the coal in the bunkers, perhaps,—carbonic acid and carbonic oxide; from the rapid combustion

of coal, candles, oil, etc.,— these gases and soot, sulphurous acid, sulphuretted hydrogen, ammonia, ammoniac sulphide (Parkes); from the galleys,— volatile animal and vegetable matters;

Fourth, from gun firing, — carbonic acid, carbonic oxide, hydrogen, sulphuretted hydrogen, suspended salts (Parkes).

Fifth, from sea spray, — salts and moisture.

From Dr. Rattray's summaries I take the following on the subject of

Carbonic Acid.

73. The results of 150 analyses prove that this is the most abundant and important impurity. By 111 Pettenkofer tests for this gas, it was shown that ships throughout are, at all times and in different degrees of crowding, pervaded by an atmosphere containing from 0.42% to 3.37%, or an average of 1.46% by volume, the oxygen being, of course, correspondingly diminished.

This gas is most abundant, and varies from 0.42% to 2.88%, when and where there is most crowding, for example, on the lower deck and

middle tiers, at meals and by night; proving that respiration, pulmonary and cutaneous, is its chief source.

Owing to diffusion, direct vitiation from combustion, the bilge, etc., and difficult, therefore imperfect, ventilation, the deeper parts of the vessel, generally, show from 0.93% to 2.64% of carbonic acid. Both from direct vitiation and diffusion, the more open, better ventilated, and less crowded main deck tier contains from 0.42% to 1.63% carbonic acid. For special reasons the air is sometimes very impure. Thus, the crowded ward-room pantry showed 1.90%, the confined, ill-ventilated store-rooms, which drew air second hand from the lower deck, from 1.33% to 1.93%, and the thrice vitiated air of the small, worse-ventilated cell or prison, derived from the store rooms, from 1.98% to 3.37% of carbonic acid.

Officers and men breathe air nearly equally impure: Ward-room cabins averaging 1.45%; main deck ones 1.03%; the well ventilated but crowded cadets' mess-room 0.79%; their study

1.54%, and in rough weather, when barred in, 2.76%; their sleeping room, below, 1.66% of carbonic acid.

"These figures show a great departure from the 0.04% (Roscoe) of the pure external air, alone fit for respiration, and a large excess over the 0.06% in our best, the 0.2% in our worst ventilated barracks (Parkes, Roscoe, Fyffe de Chaumont); and 0.08% to 0.10% in well ventilated private houses (Ertel). And they are more akin to the 0.31% (Roscoe) in boys', and 0.72% (Pettenkofer) in girls' schools, or the 0.36% (Roscoe) and 1.00% (Dalton) of crowded meetings."

74. Another able and instructive paper "On the Amount of Carbonic Acid Found by Experiment in the Air on Board Wooden Frigates," by Leonard H. J. Hayne, M.D., R.N., Surgeon of H.M.'s Ship "Doris," may be consulted in the "Medico-Chirurgical Transactions," Volume 57 (1874), page 179.

This writer differs somewhat from Dr. Rattray. He does not find as large percentages of

carbonic acid. His minimum, maximum, and average percentages are respectively 0.08, 0.22, and 0.18. He says he finds the percentage of carbonic acid in the air on board ships-of-war to be very nearly the same as exists in the air of the most crowded and worst ventilated places on shore; such as workshops, schoolrooms, etc.

75. It is easy to see that, while second-hand air may be breathed for months and even years with apparent comfort, the persistence in so doing is sure to be followed by the penalty of violence in the form of disease and early death. To show that second-hand air is incompatible with good health, it is not necessary to consider cases in which air so vitiated is breathed so habitually as in the typical instances above mentioned. The intelligent popular mind does not mistake the significance of these, nor of such incidents as that of the "Black Hole of Calcutta," in which only twenty-three out of one hundred and forty-six survived one night's imprisonment without sufficient air.

But that the breathing of air even slightly

vitiated results in violence to those who are habituated to air absolutely pure, is a fact that has not yet entered the popular, nor even the medical mind, if the latter may be judged by its *doings* rather than by its *sayings*.

M. Rochera,¹ a French naval surgeon, in his prize essay on "Sea Voyages for Consumptives," concludes that sea voyages much oftener accelerate than retard the progress of consumption; that consumption is more prevalent among marines than land forces; and that consumption is more rapid in progress on sea than on shore, etc., etc.

76. In the absolutely pure air, out on deck, the susceptible passenger will be much less sick than if he stay "below." And if he is "below" and sick, he will much sooner recover if he go out into the pure air. No part of the whole subject that concerns the ocean passenger has been more firmly established than the truth of the above statements in respect of pure air. And, as before intimated, the significance is not

¹ Hall's Journal of Health, Vol. 23, p. 48.

that the pure air has any special merit as a preventive of, or remedy for, sea-sickness, but rather that the (sometimes unavoidable) more or less impure air "below" is a factor in the causation of the illness. For the prevention or cure of that share of sea-sickness which is due to second-hand air, I would prescribe, unconditionally, absolutely fresh air all the time. If this is not always practicable, it is no fault of the prescriber.

CHAPTER III.

SYMPTOMS AND TREATMENT OF SEA-SICKNESS.

77. Among the many passengers on board subjected to about the same conditions, the degree of sea-sickness is found to vary from mere discomfort to great agony. There is a like diversity of symptoms among different persons, but for the same person at different times under like conditions the symptoms do not vary generally, but exceptionally there are sometimes great differences.

“The characteristic symptoms are headache, vertigo, nausea, pale, cool, moist skin, muscular relaxation, increased flow of saliva, sunken features, and disagreeable hallucinations of the senses of taste and smell. In fact, the symp-

toms are nearly the same as are caused by the operation of an ordinary emetic. The constipation is so obstinate that frequently there is no passage from the bowels at all for several days, nor even weeks, together. Sometimes constipation is the only symptom; some of the captains between New York and Liverpool are said **never** to have an alvine motion between the two ports.”¹

Only the symptoms that are somewhat general and constant will be regarded as interesting; because they furnish indications as to treatment, and because they shed some light on some of the mysterious processes of that sequence of events which intervenes between motion at the beginning and illness at the end.

78. Some symptoms that have been observed by me have not been noted, because they seemed inconstant and irregular, and because I was unable to find a meaning to them. It is important to ship surgeons to bear in mind the occasional occurrence of these erratic manifestations. Some

¹ Joseph Wilson, Surgeon, U. S. N., in his work, “*Naval Hygiene*,” p. 35.

of them are extraordinary. As a rule, every case of illness which I could not otherwise account for was set down as sea-sickness, however much it may have differed from the typical sea-sick case. With confidence in the conclusion, I could assure the patient that he would be all right when we got into smooth water or on shore. During the year I made no mistake in these cases. One case for example: A commercial traveler, age about thirty-three, had recently recovered from an illness, but enjoyed good general health when he embarked for a seven-days', continuous ocean-voyage. This man's entire muscular system engaged in an involuntary and uncontrollable tremor whenever he lay down, and then only; and this action persisted during the voyage. Some relief and rest were given him by means of sedatives. The only circumstance that afforded him consolation and convinced him of the unimportant character of the disorder was the fact of his being quite well when not in the recumbent position. As there was no other way to account for this action, that I could see,

I simply regarded it as a peculiar manifestation of sea-sickness. Like other symptoms of sea-sickness it subsided when the patient went ashore.

79. When sea-sick, little or much, the senses of smell and taste are in very many cases erroneous. Passengers, who on shore are reliable judges of the qualities of foods, drinks, and the art of cooking, will on the ship sometimes make most absurd complaints and criticisms in respect of qualities and preparation of foods. The illusions of taste and smell are so complete that an ordinary persuasive effort will generally fail to correct them, and many passengers leave a ship ever afterwards feeling quite sure that inferior wines were provided under cover of respectable labels; that the steward's stores were of inferior quality and got at low prices for the sake of economy; and that cheap and incompetent cooks were employed. Coffee and tea are subjects of especial criticism at sea. This was abundantly observed by me during my year on the "Alameda," particularly because

my own sense of taste was so erratic that coffee and tea seemed such abominable stuffs to me that, fond as I was of them on shore, I early in the year abandoned their use on the ship. When prepared by the same person, in the same way, of the same stock and material, when the ship lay quietly in still water fast to the dock, the coffee and tea were without the apparent objectionable taste.

In consequence of occasional complaints I sometimes inspected the steward's stores, in fact was sometimes challenged to do so, and to examine the food after it had reached the table in the steerage department. The invariable conclusion was that such complaints on the "Alameda" were based upon illusions of the senses of taste and smell. The illusions of smell are often observable. There are odors about the ship, of course. A person, not having been at sea, going on board a steamship at the wharf, will as a rule find nothing in the form of offensive odors. But let the same person go on a voyage on the same ship, and when affected

for a time by the motions, the odors, some or all, will seem to him offensive, and will really serve as an additional cause to make him sicker. The offensiveness is entirely subjective. The illusion is somewhat persistent for a variable length of time after the voyage. That is, let the person visit the ship; the odors in the first instance not offensive, then on the voyage offensive, will at time of final visit seem still offensive. With the real odors the person has acquired the habit of associating the offensive subjective constituent of the illusion, and by virtue of such habit still continues to do so. The illusion in the first instance is due to some brain disturbance, in the second instance it is due to a habit acquired during the time of that disturbance. Our freight from the Hawaiian Islands consisted chiefly of crude sugar. Some of the people, who were passengers, still persist in the opinion that the odor of that sugar was horrid, that it was the chief cause of their illness. And some have even expressed surprise that such horrid stuff and passengers should be

carried in the same ship and at the same time. The sugar, in fact, was so far removed and so well separated from passengers' quarters that, under ordinary circumstances, they would scarcely have been aware of its presence on the ship without a reminder.

That which is offensive to the olfactory sense is, on account of the abnormal condition of that sense in the sea-sick patient, represented to his consciousness much exaggerated.

The capriciousness of the patient's sensations is sometimes still worse than I have so far represented it. For it is even true that tastes and odors agreeable in health are disagreeable when sea-sick, and contribute to intensify such illness. It is more kind than wise to leave flowers in the cabin of a friend who is about to sail. Under the influence of the ship's movements he will be very likely to find the odors offensive. And if he be more wise than sentimental, he will throw them overboard, and thereby attend properly to an item which would certainly be a part of my professional advice to anyone as to

the ways and means of reducing the inevitable sea-sickness to a minimum.

80. The topic above briefly considered is interesting and practical to the extent that it enables ship officers and agents to put proper estimates on complaints, and to the extent that it enables intending passengers to be forearmed. On almost every voyage there are at least a very few who at table, either by speech or equally significant and more offensive action, make themselves repulsive to the more sensible passengers and officers. The offender in such cases will be very likely to find the better part of the ship's society thereafter somewhat exclusive; so that in consequence of his own faulty behavior the voyage to him is not as pleasant as it otherwise might have been. Aside from this practical aspect of the topic, it has an item of significance that is interesting, namely, that the subjective side of the illusion (a confusion of an objective with a subjective sensation) indicates that in sea-sickness the brain is involved. In my opinion (based on reasons appearing elsewhere)

this brain disturbance is dependent on a disturbance of brain circulation.

Another symptom very generally present has the same significance. This is the indisposition, in fact the inability, to make progress in study. Those who, foreseeing the amount of leisure time they will have, take with them books to study, literary or scientific work to be done, find, as a rule with few exceptions, that they make little or no progress in their work even if they make the effort. It is difficult enough for the average passenger to engage in easy reading, and there are enough who cannot do that. In general, what is read is very imperfectly recollected. During the cerebral disturbance the recording apparatus does not work properly. The experienced well know that, however sea-sick a passenger, and however firmly he resolves never to go to sea again, in a few days, even a few hours, his recollection of sea-sickness is already dim; and in a few months, or in the next season, he is as willing to go to sea again. Ship events and ship acquaintances are easily forgotten by those who are sea-sick.

Many passengers, even when slightly sea-sick, have a persistent bad taste. It is subjective. I was never without it, except on very smooth sea. It was more offensive when hungry than after eating. Worst on rising in the morning.

Treatment. — The preceding symptoms will be reduced to a minimum by keeping the blood saturated with nutritive material as elsewhere directed.

81. Constipation is very common at sea both among passengers and crew. It is chargeable with much annoyance, discomfort, and even decided illness which manifests itself by means of headaches in part. Easy as it is to terminate the discomfort, it is too often allowed to persist because the sufferer does not know or think of the cause himself, and neglects to consult the ship's doctor on the subject. On vessels not carrying doctors, the captain may be consulted. His long experience with the crew, in respect of this trouble, enables him to recognize it easily and advise correctly as to its treatment. I have observed the necessity on ship of distinguishing

between real and apparent constipation. When real, it occurs in those who are eating at least moderately, and who are therefore not more than a little sea-sick, if any.

There are occasionally those who are alarmed by the fact that they go two to five days without a passage, but overlook the other fact, the cause, namely, that they have eaten but little and retained less. They have retained liquid foods almost exclusively, the greater part of which was water. In such cases the stomach is empty; so is the intestine. There is little there to constitute a passage. The intestine does not so act upon its content as to move it along, unless it is about full. A cathartic dose in such a case will fail. This fact when determined by experience alarms the over-solicitous patient the more.

I was once called on by a steerage passenger in this condition who had tried full doses of four different and usually effective cathartics. His anxiety about his health was great. Some fellow passenger had advised him to go to the

doctor and get a dose of croton oil. It required much effort to persuade this man as to the nature of the case, and that croton oil was not the proper stuff. This apparent constipation is, of course, without the subjective symptoms of constipation.

82. *Treatment.* — Passengers should see that they are free from this condition at time of embarkation. And they should avoid it during the voyage. Make moderate use of moderate means. The sea-sick passenger should beware of constipation at the time when he has recovered and has begun to eat heartily. Nothing is better for constipation at sea than the “compound cathartic pill” of the pharmacopœas of Great Britain and the United States. It may be obtained of any respectable druggist in either country. For a person of average size, two pills at bedtime.

83. Another annoying symptom, often the only one present, and the subject therefore nearly well, is a very slight headache. In describing it the person may say he feels as if he has a head, or feels the presence of his head,

The sedative effect of the recumbent position with eyes closed will generally enable one to evade the consciousness of this sensation.

Hopelessness. — Dr. Beard attributes no little importance to hopelessness as a symptom of sea-sickness. Personally I have no recollection of such utter hopelessness in my own case as Beard describes; it was not even in the slightest degree a share of my sea-sickness. Nor do I recollect any considerable indications of such condition in other persons that I attended. The returned voyager seems to be afraid that his (I should say her) friends may fail to appreciate how very, *very* sea-sick — how *awfully* sea-sick he was.

“The despair, the hopelessness, the indifference as to the fate of the ship and passengers, the willingness to die, the almost hope that the ship may sink,” and so on, is talk, with very little of the signification that has been ascribed to it. “It is said that the question as to whether life is worth living is generally answered in the negative by the sea-sick.”—(*Newspaper.*) When

"the Irishman told his friend that at first he was afraid the ship would go down, but that afterwards he feared she would not," he was in a mood to amuse rather than to instruct. Sea-sick passengers are about as solicitous concerning the ship's safety as anyone else, and in my opinion considerably more so.

84. The first effect of third-class motion is some kind of disturbance of the circulation of the blood, as I have attempted to show in the discussion of motions, etc. As a result of this disturbance of the circulation, I have assumed that there is a functional disturbance of the vaso-motor and vaso-sensory nervous system. At any rate there is a general yielding of walls of blood vessels to the tension of blood within them. In the abdomen there is a very large amount of blood space confined by vessels which have not the outside support equal to that of vessels which traverse masses of muscular tissue, and much less than those which traverse bone substance.

In the disturbed condition of the function of

the walls of these vessels, they yield so easily as to be unable to resist the much increased tension, due to gravitation, when the body is in the sitting or standing position. In the erect position the walls of the abdominal vessels therefore yield and their lumina enlarge; and as the blood space is greatly increased, so is the amount of blood in the abdominal cavity. Similarly, to the extent that any blood vessel is distant from the head, and has a reduced amount of outside support, will it give way to the increased pressure of gravitation consequent on the erect position. In proportion to the distension of these imperfectly supported vessels, there is a corresponding emptying of the vessels higher up; that is, there occurs a deficiency of blood in the brain, cerebral anæmia, accompanied by all the symptoms that characterize the same *degree* of this condition under any other circumstances. It is a cerebral anæmia of a mechanical nature, and must not be expected to compare with like conditions dependent on and complicated with other diseases. This degree of me-

chanical, cerebral anæmia, or some detail of it, or dependent on it, is related to the next member in the sequence of events, as cause to effect. The next event is a physiological process. Though this relation of the two events has not been indicated, to my knowledge, by anyone, I do not offer a theory of such a relation, for I expect to be able to show that the two are in such invariable association, that their relation as cause and effect will be so obvious as not to require demonstration, much less theoretical elaboration.

85. This interesting physiological process is Nature's means for flooding the brain with blood and thereby correcting the anæmic condition. It is called emesis or vomiting. The process is entirely involuntary, and consists essentially in the inflation of the lungs, closure of the glottis, and simultaneous contraction of those muscles of the chest and abdomen which will cause compression of their contents. The pressure, thus effected, acting upon the blood vessels in chest and abdomen, and therefore upon the blood in

them, forces a part of that blood upward into the head. That the force exerted by emesis is quite competent to do this, no one who has experience can doubt.

To make the matter plain, let me picture the generalized case according to my notes from actual and frequent experience. At sea. First day out. The motions of the ship are very considerable and complex. Subject is in erect position. Begins to feel a little uncomfortable. In ten to fifteen minutes cerebral anæmia is considerable. Vomiting follows. After the paroxysm of vomiting he feels better for a time varying from five to fifteen minutes. During this time the brain again becomes anæmic, another paroxysm follows, and so on until the expulsive of muscular energy and the painful and offensive sensations attending the process have so exhausted the subject that he is forced to give up the battle and lie down. For my purpose I prefer to use the word *retching*. The expulsion of materials from the stomach and duodenum is not the object of the process; it is

merely a dependent incident, which in sea-sickness is no more essential to the process than are the groans and agony of the sufferer. In sea-sickness retching goes on at intervals long after the stomach and duodenum have been emptied and with the same persistence and energy as when they contained something.

86. At the end of a paroxysm I found, in my case, that the mucous membranes of the larynx, pharynx, upper part of the œsophagus, and nasal cavities were thoroughly congested. The evidence of such congestion was: In the larynx and pharynx, increased secretion of mucus, rusty in appearance from a small amount of exuded blood; in the œsophagus,—the unusually great sensitiveness to anything irritating or pungent in foods and drinks, as the chloride of sodium and the bromides of sodium and potassium, alcoholic and acidulated drinks; in the nasal cavities, the best parts for observation, — swelling so considerable as often to occlude the passages entirely for a short time, and increased secretion of mucus.

The secretions of the salivary and lachrymal glands were excessive. The face was flushed, and the finer vessels of the sclera, ordinarily invisible, could be seen. Retching is easy in some cases, and difficult and more violent in others. In the difficult cases the muscles involved contract more forcibly, the resulting blood pressure in the brain is greater, the congestion in general is more apparent. These excessive cases (rare) are the best to observe for purposes of study. I observed two. In either of them the usually unobservable, finer blood vessels of the sclera were easily visible. The face was very perceptibly swollen by congestion; swelling especially apparent in lower eye-lid. In one of these cases, occurring on a small steamer during a rough channel passage, there were slight but undoubted signs of brain compression for one or two minutes. The writer himself, during a prolonged paroxysm of coughing,¹ had

¹ In coughing the lungs are filled with air, glottis closes, and when the chest content is under considerable pressure, by the involuntary and violent action of the expiratory muscles, the glottis opens. But it is during the moment of great intra-thoracic pressure, before the glottis opens, that an excess of blood is impelled to the head,

his head congested to such an extent that intracranial pain was felt at the time, and a headache lasted until eighteen hours later; face was considerably swollen as above described; and there was intra-ocular pain due to excessive tension. In a few minutes all these signs of congestion gradually disappear. It is from these several signs that the flooding of the brain with blood is inferred. During the time of the superabundance of blood in the vessels, and probably in the special organs, of the abdominal cavity, there is an excess of the secretion of bile, and of gastric juice and mucus in the stomach.

87. But retching in sea-sickness must present nothing inconsistent with the same process under other circumstances. Nor does it do so. It seems to me almost certain that all cases of vomiting or retching are preceded by a certain degree of cerebral anæmia. It also seems certain that the anæmia is preceded by a disturbance of the vaso-nervous system.

While dressing a small and unimportant incised wound in the hand of a strong, middle-

aged man, he became successively pale, dizzy, and nauseated, and then vomited. He was in the erect position. There was no congestion in the abdomen or elsewhere, which might as a secondary effect cause the head to be depleted of blood. There was anæmia of the head as indicated by the paleness and the other signs. What could have been the immediate cause of this anæmia of the brain, if not such a disturbance of the vaso-nervous system as would permit a relaxation of tension of the blood-vessel walls in the abdomen, and allow a descent of so much blood as to make the quantity in the brain deficient? The wound in the hand had nothing to do with the anæmia in the particular case cited. The anæmia did not occur until the wounded hand was manipulated. No pain was caused by the manipulation. And if anyone thinks either the wound or dressing it had anything directly to do with the anæmia, let him only remember that the anæmia and its consequences occur often enough in cases of persons witnessing painful operations, or listening to their description.

Such cases would occur oftener if persons did not in response to the first unpleasant symptom withdraw from the influence of the sight or citation of the painful case. The particular case I have cited is only one of an abundant class. To witness a surgical operation used to make me sick when a boy and until after I had been frequently present (as student) at surgical clinics.

88. The case of fainting is only another instance of cerebral anæmia of greater degree. The cause operates suddenly, and the brain is so suddenly and to such an extent depleted of blood that its functions are, for the time being, at least, partly suspended; on which account it cannot evolve the necessary nervous stimulus in response to which retching takes place. But the next best thing occurs. The functions of the brain being so nearly suspended, there is a cessation to that extent of all action depending on these functions; therefore a cessation of voluntary muscular action. That is, the subject falls, so that the brain may regain its supply of

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blood by virtue of its level with the abdomen. It is my opinion that the immediate cause of cerebral anæmia in the case of fainting, is a disturbance of the vaso-nervous system, which for a time fails to maintain the proper tension of the vessel walls.

89. A drug which, even when introduced into the body otherwise than by the stomach, acts as an emetic, does so in my opinion by first causing a vaso-nervous disturbance, in consequence of which, as explained before, cerebral anæmia occurs. So that *this* is the effect of the so-called systemic emetic. And Nature herself performs the emesis in order to restore to the brain its share of blood. And here the essential thing is retching; the evacuation of the stomach and duodenum is incidental, as I believe it always is.

In cases of local emetics, other irritants (chemical or otherwise), the decomposition products of foods (in dyspepsia), the mechanical irritation of pressure on the kidney, of an impacted gall stone, of an obstruction in the intestine

(hernial or otherwise), wounds, concussions and contusions of the abdomen,—in all these there is first irritation, then pain and local congestion. There will be a tendency to cerebral anæmia in proportion to the extent of the local congestion. But following the pain there is a mental effect, an anxiety, alarm; and, through and by means of these, a vaso-nervous disturbance, as I believe, followed as usual by the cerebral anæmia in the way already explained. Here retching is also again the means by which Nature restores blood to the brain. If the anæmia is caused by loss of blood in the erect position, Nature makes an effort to retain a sufficient share in the brain in the usual way. For anæmia of certain degree, retching; for a greater degree, falling into the recumbent position, as in fainting.

“Anæmia by blood letting (when the latter is considerable) is accompanied by nausea, vomiting, faintness, syncope and epileptoid seizures.” — (Bartholow.) But in the case of the operation of blood letting, where loss of blood is very slight, the retching that is likely to occur

follows cerebral anæmia, which is induced in the same way as in the case of the dressing of a wound mentioned.

90. In the case of vomiting of pregnancy, there is an unusually large accumulation of blood in the tissues of the uterus and content. This would at least cause a tendency to cerebral anæmia. Then if the subject eat only three times a day, the interval between meals is so long that the supply of nutritive material in the blood, on account of the unusually large demand upon it, is exhausted before the next meal, particularly during the interval which includes the night. The nutritive material of the blood being then reduced to a minimum, there would be a reduction of blood bulk and therefore of blood tension, and to that extent a tendency in the erect position to cerebral anæmia.

During pregnancy the uterine region is in a condition of maximum sensitiveness, because the subject's attention is much directed to it.

By way of adaptation the uterus must continuously and gradually enlarge to accommodate

itself to the like expansion of its content. Similarly must the abdominal wall yield to the enlarging uterus. So it would seem. But Nature, as manifested in animal development and structure, is not always absolutely harmonious and consistent. If I may consider "morning sickness" as an indication of something faulty in the progress of the case, I would suppose about as follows: That the uterus is tardy in yielding to the expansion of the content, and is therefore pressed from within excessively. Or the abdominal wall is tardy in yielding to the expansion of the uterus, and the latter is therefore pressed upon from without (and by consequence from within) excessively. Or both these conditions prevail. In other words, the development keeps a little in advance of the adaptation, and violence results to the person because a condition of things is present to which the animal economy is not quite adapted. The persistence of the violence is only equal to the persistence of the slight incompatibility of the conditions mentioned. This violence manifest itself, I will

suppose, in the form of a vaso-nervous disturbance which permits, in a way explained for other cases, cerebral anæmia in any position in which the head is considerably higher than the rest of the body. The anæmia theory of "morning sickness" is favored by the fact that the symptoms are worse when stomach is empty, and worse in the erect position. This seems like a tangential divergence from the subject, but it is a part of the effort to show that cerebral anæmia (within limits) is related to retching as cause to effect, and that retching has for its object the flooding of the brain with blood.

91. A congestion must obviously be preceded by a vaso-nervous disturbance. When therefore a cerebral anæmia is due to a congestion in the trunk of the body, its cause is the vaso-nervous disturbance which permits the congestion. The accumulation of blood in the walls of the stomach at time of digestion is not properly a congestion. It is normal, one of those variations of the circulation which occur in a manner consistent with local or general influences and needs

(§39). Still, from the common stupidity of the subject at time of a full stomach, much resembling a prevalent mental condition at sea, it may well be supposed that the brain enjoys only a minimum quantity of blood at the time. The fault, however, is soon remedied by the increase of bulk and richness of the blood by absorption.

When there is sufficient cause for cerebral anæmia, it is not necessary that the subject be in the erect position. The head being to any extent above the level of the trunk is all that is necessary.

92. The abdominal wall is in health always tense. This tension is within limits constant, although the wall contracts and expands to accommodate itself to the bulk of the content. Thus, it is just as tense when, before dinner, hungry and empty, it draws one forward into a stooping attitude, as it is after dinner when more expanded. This tension constitutes the extra-vascular support of the abdominal blood vessels. There can be no doubt that, if this support be suddenly withdrawn, the walls of the

vessels will be unable to maintain their normal tension. The sudden relaxation of the abdominal wall must then, so far as it goes, serve as a cause of cerebral anæmia when the head is elevated. But relaxation of this wall *per se* probably rarely takes place, if ever; it is almost always due to sudden partial emptying of the abdominal cavity, by rectum or by emesis, or by both ways. In Nature's efforts to correct the anæmia of the first instance, due to vaso-nervous disturbance, the stomach is emptied incidentally, and the condition of things is such that the subject does not eat nor drink; thus keeping the abdominal cavity somewhat empty, and its walls somewhat lax, all which in the second instance serves to exaggerate and prolong the anæmia of the first instance.

93. This cerebral anæmia with its consequent retching is the chief constituent of sea-sickness, and the latter varies as the former. And I am here reminded that my sickest times at sea were when I ate nothing. One such occasion was especially well observed and results noted. It

was a purely accidental affair, entered upon without prejudice or expectations. We were approaching port, and I had some clerical work to be done which could no longer be delayed. The sea was slightly rough for the average passenger and considerably so for me. I was a few shades sea-sick. It was in the early part of my year at sea. Experience was accordingly limited. I had resolved to begin my work the first thing in the morning without breakfast. Was afraid to eat lest I should suffer certain disabling consequences. Determined to omit breakfast until work was done. I set about my hour's work, and had spent two hours at it, when our efficient and generous purser volunteered to finish it for me. My two hours were liberally interspersed with violent paroxysms of retching, one every eight to ten minutes; during the intervals I worked. That day was my sickest of the year. This typical instance is only cited to show how exaggerated and persistent are the anæmia and efforts to correct it, when there is a laxity of the abdominal wall because the abdo-

men is not properly filled, and when the blood is poor in nutritive material because the subject has not eaten.

94. I do not mean to say that emptiness of the alimentary canal must be attended with cerebral anæmia in the upright position. But I say this of laxity of the abdominal wall. This wall is normally always tense, whether contents be much or little. But, in adapting itself to the variations in the bulk of the content, the abdominal wall *requires time*. Thus, the intestinal content being suddenly much reduced, the corresponding adjustment of the tension of the wall cannot as suddenly take place, and in the interval the abdominal vessels will to some extent be without a part of their accustomed outside support. A case observed illustrates this very well.

A young man, member of the ship's crew, wanted a large dose of magnesian sulphate; I gave him all he wanted. Its action was sudden and extensive; the man fainted. In the recumbent position he regained consciousness very

quickly; but, during the succeeding fifteen minutes, unconsciousness would supervene if he got into the erect position.

95. The same abnormal vascular condition, which during sea-sickness permits anæmia of the brain to occur when the head is elevated, also permits congestion of the brain to occur when the head is not sufficiently elevated. The fault upon which the congestion depends, is a fault of the circulatory apparatus, and consists in a relaxation of the walls of the blood vessels. There is nothing then to prevent blood pressure from transmitting itself to the brain substance, and thus submitting it to a degree of compression that is abnormal. By personal experience I became quite familiar with this symptom. It is present (as a symptom of sea-sickness) only in the recumbent position, and of course never accompanied by retching. There is in this condition a feeling that the head through and through is too warm; there is a feeling of tightness, and a slight, dull pain; exaggerated sensitiveness, the pillow is too hard and too warm, pa-

tient turns it frequently to get the cooler side ; patient prefers to keep eyes closed because the light seems exaggerated ; he is easily annoyed by unusual sounds.

There were other signs which determined beyond all doubt that the entire head was congested, and also determined that the congestion was hypostatic — dependent on gravitation.

The lining membrane of the nasal passages and sinuses would slowly and gradually swell in recumbency, and the swelling would as slowly and gradually subside in the erect position, along with all the other signs of congestion, to be replaced by those of anæmia, if the gastro-enteric tract were sufficiently empty and the blood sufficiently impoverished.

The nasal lining membrane would sometimes be so swollen as to make nasal respiration impracticable. That on the decubital side was always most swollen, and often quite occluded. On changing sides, the condition of things was reversed in a few minutes ; the decubital side again becoming nearly or quite occluded, and the

upper side relieved. The sensation was like that of a "stuffed-head cold" without the soreness.

SECTION 1. *To prevent cerebral anæmia of seasickness.*

96. From the foregoing it is plain that, if the anæmia be prevented or corrected, the retching will take care of itself.

The subject, until he have acquired immunity by adaptation, should keep in the recumbent position when in danger of that condition. Slight dizziness, vertigo, or nausea, if increasing in severity, are severally or together to be regarded as signs of coming cerebral anæmia. In response to such warning the person should promptly lie down, having under his head only one soft pillow. He will keep his eyes shut to avoid optical vertigo, if necessary. He is also supposed to be in pure air. If the slight nausea and inclination to retching persist, he should lower his head by removing the pillow without raising his head. In this position, the vascular system also suffers vastly less disturbance from

third-class motions, as already shown (§45). The subject must remain in this position, venturing to stay up only when that may be done without the recurrence of nausea or vertigo. He may have to sit up to eat, or even venture on his feet and out for a few moments, and by such ventures will learn whether he may remain up or lie down, or keep in a semi-recumbent position in a suitable chair.

97. The subject must keep his blood saturated with nutritive material, by eating.

Dr. Beard wrote that, after he had been many consecutive months on the open sea, he would always be slightly sick, if his breakfast were long delayed. That is my experience, and I infer that it is very general. It is indicated by the fact that on several steamships that I know of, and perhaps on steamships generally, none of the officers or crew attempt any duty in the morning, except in emergencies, without first having taken their bread and coffee. Thus, I observed that the sailors were called from sleep at half-past five in the morning to take their

coffee, etc.; they then went on duty till breakfast time at eight o'clock.

Breakfast in the cabin was ready at half-past eight. To wait for breakfast two, one and a half, or even one hour, without a small amount of something nutritive to eat or drink, would as a rule involve more or less discomfort. On shore, I notice that I can as easily wait four hours for breakfast as one hour at sea. Eating is evidently a very important item in the management of sea-sickness and its prevention. Against sea-sickness, the subject must eat and drink what is suggested by his own likings, *not* the likings of others. There is only one rule on this point: *Eat and drink what you like*. As cerebral anæmia can more easily occur when food is in the stomach (§94) than at other times, subject should lie down for fifteen minutes after eating, even when not lying down generally. This rule is much observed on land; at sea it is for the susceptible a necessity. In respect of eating, the most important rule of all is this: *Eat and drink a little at a time and often*.

98. To many of those who at sea adhere to the rule of three meals a day, there will appear a bad taste (hallucination), a slight abdominal discomfort, with a suspicion or more of nausea, about half way between meal times, and several hours after the evening meal and before breakfast. This discomfort will disappear on eating, if the subject does not become sicker and unable to eat when meal time arrives. When this group of sensations takes hold of one, he should eat; the discomfort will then promptly disappear. Those who know this find that they can easily eat at such times what they rarely think of eating on land. Digestion in this condition is vigorous for *small* quantities — chips of dried beef or fish; cheese; dry bread; crackers; ginger bread; good, sound, fresh fruits, preferably acid; almonds; filberts; broths; meat teas, and pastries. Beer, ale, and porter as foods are equal to the best of these. The susceptible passenger may safely drink what he chooses, provided the amount be small at a time; it is well to say that the very thing he would most likely

overlook, and which is really safe to depend on, is cold water in small amounts. It may be taken just before, but neither during nor just after meals. Those who find it difficult to eat enough will find beer a very excellent food, taken in small quantities at a time.

Eat and drink a little at a time. Some need this caution; many will be informed by their own sensations when to stop. However, at sea, "nothing is more fallacious than the evidence of the senses." For my purpose I chose fruits, the first thing in the morning and between meals. Nothing available on the ship could for my purpose have replaced the apple. The necessity for eating often grows out of the inability to eat much at a time, either because one does not feel like it, or he has found by experience that the ordinary quantity will not be digested without trouble. The general impracticability, on the part of the new passenger, of digesting the usual quantity at a time, is due, I believe, to the fact that the presence of food in the stomach favors the occurrence of cerebral anæmia, and in

proportion to the amount in the stomach. But aside from this, it has happened often enough under my notice that a quantity as large or larger than usual in the stomach is followed by the regular land symptoms of acute indigestion, with and without vomiting. These cases are chiefly, but not exclusively, confined to passengers who are but slightly sea-sick, and to officers and crew. Persons so affected are subject to like disturbances on shore. Such dyspepsia at sea forms, I believe, no part of sea-sickness. The stomach, in my opinion, is not involved in sea-sickness, except incidentally, as already explained in the discussion of retching, and except the excessive secretion (spoken of) dependent on the presence of an excess of blood in the abdominal cavity when deficient in the head.

99. It is difficult to say just how much is meant by *a little*. It must have a different meaning for different individuals, and at different times. *Digestibility* and *nutritive value* should be considered, if one cannot be governed by his sensations. Bulk is not an important

consideration. For instance, when the sea was a little rough, and I therefore had to make some effort to keep my inevitable share of sea-sickness down to a minimum, the *little* that would brace me up until meal time was half an ounce of chipped beef or cheese, six to eight almonds, or two medium-sized apples. I am of average weight. No sensitive person, a stranger at sea, or otherwise not a good sailor, should attempt to get out of his berth in the morning, sea rough or smooth, without having eaten a little of something at least fifteen minutes previously. Ever so many ladies get violently sea-sick while dressing who would not, did they observe this rule. On land it is a pleasure to eat; at sea it is for many a somewhat difficult duty. At sea, he that can but does not eat because he is sick, will *surely* be sicker because he does not eat when he can. The susceptible ocean traveler should not delay in responding to the sensation of a full bladder or rectum. These sensations, and the consequent attention to the parts involved, cause an increase in the amount of blood to those

parts, and to that extent favor the condition of cerebral anæmia.

SECTION 2. *To correct cerebral anæmia of seasickness.*

100. The person having cerebral anæmia is, of course, also suffering from nausea and, perhaps, retching. He should have fresh air. He must lie down, with eyes closed, using only one soft pillow, and, if still in danger of retching, he should, without raising his head, remove the pillow, or even hang his head over the side of the berth so as to have it lower than his body for a few minutes. Retching will thus be made to subside. To prevent recurrence, the patient must for an indefinite time *keep* in the recumbent position, with eyes closed. During this indefinite time he must saturate his blood with nutritive material by eating. This seems impracticable to many of those who recollect being in this condition. It seems especially impracticable to the patient at the time. But there is a way of eating which succeeds in this condition. And there are materials that will stay down. I

speak from an abundant personal experience and observation, and do not hesitate to say that it is easy, by pursuit of the proper method, to restore a patient from the most distressing degree of sea-sickness to a condition of comparative comfort (not health) in fifteen minutes. And by the same means, which have not yet failed me, I have repeatedly enabled such patients, in the course of six hours, to resume eating, as usual, enough to sustain them very well. The simplicity of the management is almost disappointing, but will seem rational to those who have read the preceding discussion of the causes and symptoms of sea-sickness. If I here give the management of an extreme case, the intelligent reader will understand the conduct of the more hopeful cases.

101. What is an extreme case? It is a lady, young or old, delicate or otherwise, who becomes sea-sick in a few hours after starting. At first she empties her stomach and duodenum by emesis. The violent, involuntary, muscular action of the process is fatiguing and painful to

her. Muscles involved, in a few hours, become sore and painful. She is at various times sitting, semi-recumbent and recumbent. When in the recumbent position she will have under her head the two pillows that belong to the berth. She has occasionally attempted to eat, but has retained nothing. She has a most distressing paroxysm of retching at intervals of fifteen to thirty minutes, according to her available strength and relative position of her head. The air in her cabin is decidedly second-hand, either because it is not open enough, or because too many friends or occupants are present. Friends, strangers, and ship employees offer considerable advice, not quite practicable, and confusing and annoying, because conflicting. So far the case presents nothing alarming nor unusual. When this condition has continued for from sixty to eighty hours, the patient having grown weaker and become alarmed concerning her condition, then the case is an extreme one.

102. The details of the general treatment, as already directed, having in the case of such a

patient been carried out, it only remains that she shall eat. She must eat foods in liquid or semi-liquid form, that are not irritating, rich in respect of nutritive constituents, easily digested and quickly absorbed. She must take very little at a time and not oftener than at intervals of ten minutes. As a result of several doses the patient generally feels so much better as to be able to sleep; she should then not be awakened for the purpose of eating. The best of all foods that are available for this purpose, and the one I invariably prefer to use *first* in such cases, is prepared by thoroughly mixing the yolks of two raw eggs with an equal bulk of good brandy. This will stay in the stomach. It would be difficult to exaggerate its value for the purpose. The brandy is momentarily irritating to the upper part of the œsophagus, because the latter, after retching, is for a time congested and sensitive.

When the patient shall have consumed this allowance, *in teaspoonful doses at ten-minute intervals*, she will be able to continue eating right along, but may next take some other preparation

of the class of foods defined. The all-important rule of small quantities at short intervals must not be neglected. And, lest there be any question as to what is a small quantity, I should say that, next after the mixture of egg and brandy, a dessert-spoonful would be a small quantity; or a table-spoonful, if the patient be absolutely free from nausea. In case of a doubt as to the amount, decide on the smaller. A pint of beer, ale, or porter, in six to eight doses, at ten-minute intervals, is more convenient and scarcely inferior to the egg-and-brandy mixture, and often preferred because more agreeable.

A reasonably extensive variety of food preparations is available on all first-class passenger steamships. At meal-times passengers should speak for, and cause to be provided, whatever they *need* for use between meals and during the night. Being reasonable, moderate and timely in their requests, passengers should require prompt responses from the attendants. At sea hunger cannot long be endured; if not *very soon* satisfied, it rapidly merges into illness, when the

patient "cannot eat" what he called for and could have eaten ten minutes earlier.

103. By continuing this graduated feeding, and keeping in the recumbent position as directed, and by common-sense intelligence for contingencies not necessary to anticipate here, the patient will have made a sixty to seventy per cent. reduction of her sea-sickness in six hours. And she will be able to make an ultimate ninety per cent. reduction in twenty hours more by continuation of the same management. As the patient improves she may eat more varied foods, in larger quantities and at longer intervals. She will need her common-sense right along, and ought not to yield it for advice in which common-sense is not apparent. Just when she may venture to get up and out, and how long she may stay out, will be determined by her own sensations. It will not be until she eats moderately well and can remain upon her feet without the recurrence of nausea. When there appears a slightly uncomfortable sensation about the stomach, with perhaps very slight

nausea or an offensive, bitter taste an hour or more after eating, the patient by eating again will find these sensations disappear.

SECTION 3. *To correct cerebral congestion of sea-sickness.*

104. As previously shown, the cause of cerebral anæmia in the erect position will serve as the cause of cerebral congestion in the recumbent position if the head is too low. Such congestion will be easily recognized from the description of its signs (§ 97), and the intelligent sufferer will see the necessity of elevating the head to some extent.

105. Among the sea-sick ladies there are frequently some that are *enceinte*. These are among the most susceptible; probably because of the already present inclination to "morning sickness." There is a popular and a professional belief that during sea-sickness there is more than usual danger of miscarriage. Dr. Beard says: "Dr. Fordyce Barker is quite decidedly of the opinion, derived from his own expert observation, that travel by sea is not likely to

induce miscarriage." He is quite right. Management of such persons in sea-sickness is the same as for others. They will persist longer, and may have to remain in a recumbent or semi-recumbent position all the voyage. One such patient of mine was unusually persistent in retching and had great difficulty therefore in retaining anything. To profit by what she ate, it was imperative that she remained recumbent while eating and for at least an hour longer. And as she ate but little at a time and often, she was required to remain recumbent practically all the time for seven days. This patient occasionally got up, but invariably suffered for it if she remained up more than a moment. This was one of those passengers whom the doctor simply keeps alive; whose feeding requires his attention and no little thought, if the voyage be a long one.

How long in Recumbency.

106. The consideration which determines this point has already been given. It should, however, be stated in other terms, namely, that posi-

tion must be kept until the subject has acquired immunity from the disturbing effects of motions. This immunity is the result of adaptation to the motions. The department of the anatomy mostly involved in the adaptation is the vaso-nervous system. It has already been shown that in the erect position one suffers in every respect more disturbance from third-class motions than in recumbency. The time required for adaptation varies from a few hours upwards. The majority are used to the motions in sixty hours when the sea is comparatively smooth. A longer time is required to the extent that the sea is rougher.

107. Immunity from sea-sickness is relative, not absolute. It happens on long voyages, when out a week or two and all well and used to the sea, that the sudden occurrence of stormy weather and sea causes nearly all the passengers to get sick again. As a typical case I may cite that of an officer who has been at sea for the past twenty-eight years. He gets sea-sick whenever the sea is really rough. His general im-

munity from sea-sickness holds good in respect of those motions to which he is most *frequently* subjected. But he suffers violence from those motions to which he is *rarely* subjected; because they are neither of sufficiently long duration, nor of such frequent occurrence as to give the system time for the formation of an adjusting habit and to insure the maintenance of that habit. In my two hundred and seventy actual days on the Pacific Ocean there were now and then moderately rough times, but only one time (50 hours) when it could be said there was a storm. Absolute immunity, therefore, is not to be expected, not even by sailors, much less by passengers — the unaccountable exempts, one in two hundred, excepted.

108. The formation (growth) of the adjusting habit sometimes requires a long time on ordinary sea. I saw a lady who failed to get used to the ship's motions in a seven-days' continuous voyage of average weather. The same lady told me that, when years ago she was a passenger on a sailing vessel going from Boston around Cape

Horn to Honolulu, she was sea-sick thirty consecutive days.

There are not a few people who, during the entire course of a voyage across the Atlantic, must remain in the recumbent position. In this position these susceptibles, if they attend to themselves as herein directed, will suffer *vastly* less discomfort than otherwise.

109. The formation of the adjusting habit would, without doubt, be accomplished vastly sooner if it had the benefit of the subject's volitional attention and his mental energy. But the employment of voluntary attention and mind to that end is impracticable, except when the exposure to third-class motions is to continue only two or three hours. No one is able to evolve sufficient mental energy to maintain volitional attention uninterruptedly for more than two or three hours; and those who start on a voyage, and attempt, by help of mind, to evade sea-sickness, will by virtue of this useless sacrifice of mental energy collapse with all the more violence and agony when mind is ex-

hausted. We hear it said, even out at sea, that mind has a good deal to do with sea-sickness; that one will or will not be sea-sick according to the way he makes up his mind. Yes; it seems that mind has much to do with the case, if the inference may be drawn from the few known examples of great minds coupled with equally great susceptibility to sea-sickness!

“Jacques Arago, during his four years of circumnavigation of the globe, frequently suffered from nausea and vomiting.”

“Cicero, when he took refuge on board a vessel after his proscription, suffered so much from sea-sickness that, preferring the fate that awaited him on shore, he landed at Gaeta, and there suffered decapitation.”

I was told, by one who knew him personally, that the great philosopher, Charles Darwin, during his five years' voyage on the ship “Beagle,” never acquired immunity from sea-sickness. He was probably not sea-sick all the time, but only when the sea was otherwise than calm. It was to having been sea-sick so much, that he attri-

buted that lifelong sensitiveness and excessive susceptibility to disturbances of health upon slight provocation.

“England’s greatest admiral — Lord Nelson — is said to have been one of those who never got habituated to the ‘thud’ of the sea.”

Sir John Franklin was also on this list. It is also a matter of personal observation, and I might, if it were proper, mention other names of wide-spread familiarity.

110. The same inference may be drawn from the exemption of persons whose volitional mental activity is suspended entirely, namely, mesmerized subjects, insane persons, and subjects of *delirium tremens*. Both the preceding considerations, and personal experience and observation in abundance, show that adaptation to ship’s motion will succeed best when unassisted by any mental effort whatever. It will succeed best when the nervous system is left to operate in its own automatic way unconsciously. The man, mentally and physically vigorous, who remains on his feet determined to resist sea-sickness, has

no better luck than if he lie in his berth as passive as a rag. His system adapts itself to the motions no sooner than, and I believe not as soon as, that of another who lies passively in his berth in natural or induced sleep.

111. In accordance with the preceding views one item in the management of cases, as given on previous pages, is to secure a condition of person in which volitional activity will be suspended or reduced to a minimum. The recumbent position, with eyes closed and room quiet, associates with itself, by virtue of habit (in health), at least a superficial degree of sleep, at least a partly subdued consciousness, in which one is almost oblivious to things unpleasant and to length of time, and may even have pleasant dreams. I say *at least* and *almost*, because when one sleeps profoundly in the night it is not generally practicable to sleep all the twenty-four hours. But it is practicable to maintain a semi-somnolent condition. And in doing so, one is aided by the sedative effect of the ship's motions when not too violent. I have always suc-

ceeded in doing so at will. The efficiency of this procedure can best be illustrated by relating the circumstances of the following case: In June, 1885, the officers of the little steamship "Dowsette" invited me to make a trip with them from Honolulu to ports on some of the other islands. I gladly embraced the opportunity to learn by experience what I had read and heard about the intense degree of sea-sickness on channel passages on small vessels. I fully expected to be unable to avoid being considerably sea-sick. Nearly amidships and as high as the rail was a pile of lumber. On this I had a mattress placed, very near the rail for obvious reasons. By the time the ship got out of the harbor I lay on this mattress, out in the open air, with eyes closed and without a pillow.

The little steamer responded promptly to the motions of the sea, which was in its average mood. The movements of the ship were quick, and the number of variations of movement were vastly greater in a given time than on a large steamer in a similar sea. This greater

number of variations, together with the suddenness of their occurrence, is what determines the greater prevalence and greater intensity of seasickness on a trip like this. When, after the first six hours' run, we landed on Molokai, I was greatly surprised by the fact that I had been only very slightly sick. There had been a slight excess of salivation and slight cerebral congestion, which latter is only slightly inconvenient, and vastly better than the anæmia and nausea and vomiting that must have been present with the head raised on a pillow or two.

My sea-sickness on this run was, I guess, a ninety per cent. reduction from what it would have been had I stood, sat or walked, looked and talked, as almost everyone does during his first hours at sea. I was equally successful on the remaining runs of the same voyage whenever I attempted prevention in this way. After the first run I frequently got upon my feet and went about the ship, but was never up long until nausea came on, and then I would quickly lie down, shut my eyes and thus avoid retching.

Of course, during the entire fifty hours of sailing, I at least once tried the comparative effect of remaining in the erect position. The slight premonitory nausea was in about a minute followed by retching with its miserable accompanying sensations. I did equally well on the thousand-ton steamer "Kinan," during the sixty hours of delightful steaming which forms part of the round trip from Honolulu to that *wonderful Volcano of Kilauea*. On the smaller steamer I neglected the detail of prevention relative to eating, and found that one could keep nearly well in the recumbent position when eating only three times daily, and therefore much less than usual, because one cannot, when slightly sea-sick, eat much at a time. On the larger steamer I attended properly to the matter of eating. The difference was, that in the latter case I was able to be up and about longer at a time, with less tendency to nausea in the erect position.

112. I speak of the above experiments because in them the efficiency of the prescribed preventive means was thoroughly tested on a

very susceptible subject. And on this matter of susceptibility, which must be considered in judging all such as the above cases, I must confess that on four trips, of the respective durations of nine, twelve, sixty, and sixty hours, before I had an idea on sea-sickness, I enjoyed the distinction of being much the sickest passenger on board. On the "Alameda" I was never quite well except when "the sea was as smooth as a mill-pond," which was not a very frequent condition. I made but little progress toward immunity even in such long runs as those from San Francisco to Australia and return, twenty-three days each way.

The means that I have advised for preventing and subduing sea-sickness were amply tested by me and found to be quite as efficient as represented. During a year's service as medical officer of a passenger steamer, these means were practiced on myself and on numerous passengers.

113. The now extensive use of the bromides in prevention and treatment of sea-sickness is

chiefly due to Dr. Fordyce Barker, Dr. F. D. Leute, and the late Dr. G. M. Beard. It is Dr. Beard to whom we are indebted for the facts that bromide of sodium is the preferable agent to be used in prevention or treatment of sea-sickness by medical means, and that immunity from sea-sickness depends not upon the bromide, but upon that quantity, carefully and gradually administered, which will produce in the person the condition known as bromism. Beard says: "The signs of bromization that are to be looked for by those who are taking the remedy with a view to prevent sea-sickness, are — weakness in the limbs, and sleepiness and drowsiness by day, a disposition to fall asleep, and, withal, an indisposition for active exercise. These are not all the signs of bromization, but they are sufficient for the purpose in hand — that is, to teach and tellus that the nervous system is so far under the influence of the bromides, that it will be likely to be able to endure the agitation of the vessel at sea."

That semi-somnolent condition, which, by

virtue of habit, associates itself with the recumbent position when eyes are closed, is similar to what seems to be the main feature of bromism, namely, "drowsiness and sleepiness and a disposition to fall asleep by day" as well as by night. Immunity from sea-sickness, thus secured, seems to be attributable to this feature, whether induced by bromide of sodium or by recumbency with eyes closed, in which consciousness subsides to such a degree of inactivity that impressions stop short of becoming the sensations by which the subject knows he is sick.

But my management makes something like a ninety per cent. reduction of one's otherwise share of sea-sickness. Suffering then still a little sickness, of which he is kept conscious by a group of offensive sensations, the patient may go a step farther and enjoy apparent immunity by allowing himself to get into that semi-somnolent condition during which consciousness is exclusive to the unpleasant impressions. He is, however, a little sick, even if not aware of it.

Whether or not the immunity conferred by bromism is real or apparent, whether or not it is a contrivance for making one insensible to his sufferings, I do not know.

I have observed trials of Dr. Beard's prevention and treatment, and have prescribed his means and methods, with results that were quite consistent with his claims.

114. I believe that in the bromized state of the person there is a minimum of volitional activity and a maximum of automatic activity. This, as we have seen reason to conclude, is the condition of person most favorable to adaptation to ship's motions. To this feature of bromism I would ascribe the alleged superior sailing qualities of those persons who have emerged from several days' bromization, in comparison with those who wasted much mental energy in fighting they knew not what, and succeeded only in interfering with nature's automatic efforts to form the adjusting habit.

But in this respect the bromized person has no advantage over the one who will immediately,

on departure of the ship, lie down and stay there for forty-eight hours, more or less, as his case may require. Making further comparison, it is observed that Dr. Beard's management will prepare the passenger for rough seas; for, to make sure of success, he must prepare for the worst. This is very well for those exceptional susceptibles who would be considerably sick on the smoothest sea, and foreknow it from experience. But in cases of passengers going to sea for the first time, bromization on embarkation would often only incapacitate them for that enjoyment of the trip which the fair weather and sea often permit. Or it must sometimes so happen that a person even in rough sea would have suffered only a little or no sickness without the bromization, which latter then only unnecessarily compels the subject to sleep when he might otherwise be imbibing the poetry of a practical "life on the ocean wave," etc.

Beard's management almost necessarily involves the aid of an intelligent physician who has read his book. Such a person is at present

rare on the seas and elsewhere. To take bromide of sodium heavily for at least two days before embarkation would generally incapacitate one for a multitude of business and other affairs, that must usually be attended to on the last one or two days before departure. Bromization would be impracticable for an officer of the ship or any one else who has duties on the way; it would almost entirely incapacitate them.

115. My method is quite as efficient as Dr. Beard's. It has not the anti-drug prejudice to overcome. It involves no risk of evil effects from careless or unintelligent use of drugs. It in no way interferes with the enjoyment of the trip when weather and sea are favorable. It is easy to understand just what the effect of every detail is. It is practicable for officers. The captain can lie on his sofa, do his necessary thinking as usual, receive reports and give commands. The ship's surgeon is often a stranger to the sea. He must have his wits about him and be ready for emergencies. He cannot, therefore, afford to bromize. He has sufficient

time to lie down, and is generally sea-sick at first. To him my treatment is available, and will only be interfered with by the occasional calls that require him to be on his feet for a short time. The mail agents on ships, like those on trains, have duties. They do have some time to spare and may use it in lying down if sea-sick during rough times; but for time so lost they must work more hastily in better weather, and therefore cannot impair their ability by bromide of sodium.

Fear in Sea-sickness.

116. To ten chief stewards of passenger steamships the following question was personally put: "Does excitement in cases of alarm of fire or other danger influence the case of sea-sickness?" From nine stewards answers were obtained as follows:

Nos. 1 and 2. — "No."

No. 3. — "It cures all."

No. 4. — "It cures all without exception."

No. 5. — "It effects a cure immediately, and they remain cured for the entire voyage."

No. 6. — "Fright generally cures the ease permanently."

No. 7. — "Helps them to start up, but does not cure them even for a short time."

No. 8. — "Relieves them for the time."

No. 9. — "Helps wonderfully; an alarm of real foundering started all out, great numbers of whom were sea-sick. Majority actually recovered and remained well."

Captain Henry G. Morse, of the "Alameda," is quite firm in the opinion, based on observation, that an effectual and speedy way of curing sea-sickness consists in making the patients angry or frightening them. I have not witnessed the experiment. Although this treatment could not become practicable, demonstration of its possibility would be at least theoretically valuable. And Captain Morse ought to contribute to the literature of the subject that which he has gathered in his forty-one years at sea. Among those who have had the best and most opportunities for observing on this point there are different views. So far as my super-

ficial inquiry goes, the balance of testimony is in favor of the curative effect of fright. This view, however, has little support of analogy. It has not the support of a single known principle of mental or animal physiology. It is asserted upon alleged observation, of which no circumstances are given. It has no place in the literature of the subject, excepting the mention (so far as I know) of one case,¹ another mere assertion of an observation.

117. I shall take my position with the minority, with those who say that fright relieves sea-sickness *temporarily*. I take this view because complete *temporary* relief by operation of fright comes within a class of phenomena that is fairly understood and admits of satisfactory explanation.

A person may be decidedly unwell and not aware of it. If the abnormal state of things within him gives rise to abnormal sensations, then he will by these latter know he is sick. But these sensations involve attention, and

¹ Amer. Jour. Sci., vol. 34, p. 17.

attention may be diverted so that during the diversion the subject is entirely unconscious of his illness and the painful sensations. Attention responds to stimuli. In response to stimuli sufficiently powerful, the attention may be diverted completely from the most painful sensations. When the attention has been held by some powerful stimulus, it has often happened that the subject has received serious and great bodily injury without having been aware of it until the attention was released. These facts are amply illustrated by cases in the memory of every intelligent adult. Some very remarkable cases of this kind are cited by Dr. W. B. Carpenter, in his "Mental Physiology," page 138.

To the category of such cases belongs that in which a sea-sick individual is made temporarily unconscious of his illness by having his attention diverted by circumstances that serve as causes of alarm.

118. There is a well-known class of phenomena which proves conclusively, that the utmost mental or muscular energy that we can appro-

priate at *will* is but a *small* part of that which is available in response to an extraordinary stimulus. Many will recollect cases like that cited by Dr. Carpenter, in which an old cook-maid tottering with age, on the occasion of an alarm of fire, seized a large box containing all her goods and walked down stairs with it as easily as she would with a dish of meat. But it required four men to carry the box back. There need be nothing incredible in an account that represents a half-dozen men very sea-sick during several days of stormy weather, and that then in case of disaster these very men get right up and do most fatiguing duty for hours together in order to save life.

CHAPTER IV.

TREATMENT RECAPITULATED.

119. At present, without drugs, sea-sickness cannot be entirely prevented. By my method it is easy to make a reduction of ninety per cent. of what the inexperienced patient would otherwise suffer without aid. Of Dr. Beard's prevention and treatment one thing is certain: he has made a great blessing available to the susceptible ocean traveler.

Bromism is an obscure condition. Even when every observable phenomenon is described, our knowledge is unsatisfactory, because not all can be observed and the significance of that which is observed is for the most part unknown. Does bromization serve as a means for making one insensible to his sufferings? Is bromism an

easily endurable condition that may be substituted for an intolerable one? It is probable, as intimated elsewhere, that in sea-sickness, between cause and effect, there are many nervous impulses, to and fro, direct and reflex, between seats of disturbances and nervous centers; and that the magnitude of the complex effect is due to the facility with which the disorder is spread by the easy automatic action of the nervous conductors. The bromides seem to render nervous conduction so difficult as practically to reduce the number of impulses to a comparatively small sum and the dependent mischief to a minimum. Then by making consciousness more than usually exclusive the subject is even oblivious to the minimum of functional disturbance which is present.

Dr. Beard's method of prevention and treatment of sea-sickness by bromide of sodium is available to any intelligent person who will give his book ¹ a careful reading, or who will consult a reliable physician who has read it. Physi-

¹ E. B. Treat, Publisher, 757 Broadway, N. Y.

cians who have not read the book cannot be depended upon in this respect. I have within eighteen months seen two steamer surgeons who affirmed that the bromides were of little or no use against sea-sickness. They thought they knew how to administer bromides, but I found that they did not know how to use bromides against sea-sickness. In this port (San Francisco) the steamship surgeons who have read Beard's book are at present rare. It seems to me that a steamer surgeon is inexcusable for being unable to provide the often much-needed relief which Dr. Beard has shown seven years ago to be so easily available. I have not quoted from Beard's work so as to enable the reader to employ the treatment by bromide of sodium, only because I could not within the justifiable limits of a quotation appropriate enough for that purpose. Beard's method is in general very good. By comparison (§§ 118, 119) I believe I have shown my method to be the better.

120. I will here briefly recapitulate the details to be observed in applying my method to a case

whether for prevention or treatment. Absolutely fresh air. Eyes closed to exclude optical vertigo. Recumbent position to prevent or stop nausea or retching; one pillow or none. If congestion of the head occur, raise the head on a pillow or two, or sit up awhile. Keep the blood saturated with nutritive material. When there is inability to eat enough at a time, eat oftener. If susceptible, never get out of bed in the morning or any other time without having eaten something at least fifteen minutes before. If patient is very sick and appears unable to eat or retain food, he will be able to take of the mixture of brandy and yolks of two raw eggs in teaspoonful doses at ten-minute intervals (§ 107), or a pint of beer, ale or porter in six or eight doses at ten-minute intervals. He will next be able to take beef-tea, or meat-broths, in tablespoonful doses, and may venture on solids of his choice, meanwhile keeping in the recumbent position with eyes closed. When the patient begins to eat heartily, he should beware of constipation. So should they who are but

slightly sick. At first few meals, moderate eating, should be the rule for those who are, as they say, not sick. Digestion at sea is sometimes capricious, and sea-sickness often begins with dyspepsia consequent on excessive eating. Any alcoholic liquors, if used by the sea-sick, should be taken in unusually small quantities at a time. Whenever the quantity given (of any food) does not stay down, try less at a time and at shorter intervals.

“The time is to come when those who go to sea for duty or pleasure, will, in cases of liability to sea-sickness, consult their physician, just as they now consult him when entering a region subject to malaria or yellow fever, and shall receive, instead of jokes or indifference, careful and systematic directions for their voyage.” — (*Beard.*)

CHAPTER V.

SOME GENERAL CONSIDERATIONS.

SECTION 1. *To the uninitiated.*

121. That sea-sickness, unrestrained, is a very miserable condition to endure, need only be said to those who have not been on the sea. To convey an idea of it to such persons, it may in its severer stage be likened to the condition of a person responding to the stimulus of an emetic. The severest degree of sea-sickness may be estimated by supposing an individual to have fasted for sixty hours and then be subjected to an effective emetic dose. The agony is great. Owing, however, to its own implication, the recording apparatus of the brain does not make a clear record of it, and the great agony is

already in the dim and neglected past within the day the voyage ends.

Sea-sickness is a functional disease. That it is not a profound, dangerous, nor even a serious disease, may be inferred from the suddenness with which complete recovery almost always takes place in a few minutes after landing. If it is dangerous to the life of animals, it is not necessarily so to man, who is vastly better situated on ship and has the liberty, the space, the intelligence and the accumulated benefit of preceding experience to adapt himself to conditions: all of which the animal has not. The horse, for example, when shipped, has not room to lie down, and if indisposed to eat of the limited variety of food offered, he gets no other. Man will eat from obvious necessity when food is repugnant; the horse, of course, will not. The horse is a gregarious animal, capable of alarm, and is, as I have observed, very anxious and restless when suddenly taken from home and kept for a night by strange people in an altogether strange place. The horse's position on

a ship must be to him altogether incomprehensible, and there must undoubtedly be considerable mental violence in the constitution of his sea-sickness. The difference of conditions of man and animal on ship is even greater; but it is so far plain enough why the animal is liable to perish while the person is without danger.

SECTION 2. *Animals get sea-sick.*

122. Dr. Fordyce Barker observed that cocks and hens, and dogs and horses, got sea-sick; that one of a pair of horses died of sea-sickness, while the other was not sick. That aquatic birds get sea-sick has been mentioned (§ 13). Dr. Frank Cowan, of Greensburg, Pa., informed the writer that he had observed that spider monkeys, the most expertly active of all monkeys, got sea-sick; that one of their abnormal procedures in this abnormal condition was the gnawing of their tails.

A naval officer told the writer that he was never able to keep sheep fat at sea. How could this be explained, except the sheep be a degree or more sea-sick? I have no doubt that among

animals deaths at sea are *often* due to sea-sickness. I have not investigated; but, from limited observation, I suspect that the death-rate of animals at sea is large. A dead animal is shoved overboard with so little ceremony and so little and superficial inquiry as to cause, that it cannot generally be known whether or not the cause was wholly or partly sea-sickness. And the most that one can get from those in charge of the animals at the time is, "Don't know." Out of thirty-six turkeys lying with legs tied on the upper deck of a channel steamer, I observed that twelve were dead. It was on a choppy sea, rather severe on anything susceptible, and I suspect sea-sickness, together with the hardships incidental to shipment, as the cause of the mortality.

SECTION 3. *Deaths from sea-sickness.*

123. In more technical terms Dr. Beard says; "Nervous exhaustion and poverty of blood resulting from sea-sickness may, in rare cases, go on to death, either at sea or after landing. A number of cases of this kind have been reported

by Barker and others, in sufficient detail to leave small chance for doubt in regard to the recognition of the cause. Beard further says he has never met with a case of the kind, although a number of instances have been reported to him, on authority not entirely satisfactory. Nor have I any case of death to report. A case of death from rupture of an aneurism was reported to me. There is no doubt that retching will hasten the development of aneurisms, and those well developed are in danger of being ruptured by retching. The recumbent position obviates this danger, as it does the danger (if any) of miscarriage. There can be *no apology* for letting anyone die of sea-sickness at this late day on steamers carrying doctors. People will now and then die in consequence of the disease with which they embark. Invalids frequently start by sea for destinations which they have but little hope of reaching alive.

SECTION 4. *Taking "colds" on disembarking.*

124. Passengers are subject to "colds" at sea as on land. "During the war I was nine

months at sea, without once going ashore ; and, on approaching New Orleans, I was told by one of the old sailors that we should be very liable to take cold as soon as we landed. I took every possible precaution myself, and asked the officers and men to do the same, to see if we could possibly avoid this ; but, in spite of all these precautions, I believe nearly every person on that ship took severe colds, some even extending to bronchial difficulties, lasting for several weeks, so that I was obliged to treat them." — (*Beard.*)

"Colds" under these circumstances are more likely to follow a long voyage than a short one. I will venture to assure passengers that, if they will take cold baths, at least end their warm baths with cold water, and manage to breathe pure air on shore, they will avoid "colds." To this end they must remember that the air is too largely second-hand in all public assemblies, in hotel assembly rooms (generally), in doctors' waiting-rooms, and in family assemblies, especially in the evenings when greater numbers are

present and rooms are more than usually closed and gas is liberally burned. Let them not, withal, forget to increase tenfold the efficiency with which their rooms at hotels or elsewhere are ventilated.

SECTION 5. *The ocean as a health-resort.*

125. The ship at sea as a health-resort has no special advantage as such. A great deal toward improvement or restoration of health is often accomplished simply by a thorough and extensive change of one's circumstances. The easiest way I know of to secure such change temporarily is by going to sea. One has more exercise on the ship than is generally supposed. It is practicable for many to promenade much of the time after a day or two out. But exclusive of this, the constant, automatic, muscular action involved in maintaining one's adjustment to the ship's motions amounts to considerable exercise in the twenty-four hours. And all the better because it is automatic and not involving mental effort. And fortunately there is all the more such exercise when promenading is impracticable

on account of rough seas. If it is desired to put a person beyond the reach of his work, and into a condition in which he is pretty certain to feel indisposed to make any mental effort, and where he will find pleasant company and all the conditions for absolute rest of mind, let him go to sea. Let him go on a good steamer, on a pleasant voyage, in a pleasant climate, to a pleasant island, where he cannot hear by cable nor for several weeks by mail from his business; but where on the contrary he will find new, unusual, interesting, amusing, instructive, invigorating diversion. Were I the medical adviser of such a person on the Pacific Coast, I should advise a trip to the Hawaiian Kingdom. The twenty-one hundred miles of distance from San Francisco, the seven days going, the gradual transition from a temperate to a tropical air and sea; the perpetually green islands, the land without a beggar; the world's greatest extinct crater, the liquid lava lakes of *Kilauea* in perpetual ebullition; the sugar plantations, the banana plantations, the cocoa-nut groves; the

delightful inter-island voyage involved in seeing some of these sights; the remarkably beautiful city of Honolulu, its abundant, varied and exquisitely charming, tropical vegetation (selected years ago from all other tropical countries in the world), its good-natured and happy natives and the four thousand whites of several nations, intelligent, industrious, well-to-do, not exclusive, but manifesting a kindness and hospitality which is got of and equals that of Nature herself as exhibited in the unusually pleasant environs with which these happy, Christian people are surrounded; the return trip of seven days, with its gradual transition from tropical to temperate air and sea; the exceedingly pleasant effect of arriving "home again from a foreign shore," and many other incidents to a journey like this, which for happiest effect should be realized without anticipation — these only too superficial hints may convey an idea how successfully and pleasantly a certain class of patients may secure that absolute rest and diversion from their business, which the condition of their health demands.

SECTION 6. *Pleasant voyages.*

126. I have written as though a voyage could be selected which would be a pleasant one. So it can, with a certainty that is little less than absolute. If a large, modern, passenger steamship be chosen, the voyage on the Pacific Ocean, in seasons or latitudes not too cold, would scarcely fail to be pleasant. The merits of a voyage can best be judged when it is a thing of the past. It is then considered as a whole, including its anticipation, its events, its friendships; and not least among the belongings of a considerable voyage are the memories of it. The memories of a long voyage are a perpetual source of pleasure, a never-failing and satisfactory profit on the investment involved. Thus I do not in the least hesitate to say that every voyage of my year on the Pacific Ocean was a pleasant one; only one real storm in all the year, and not a half-dozen squalls, any one of which I should regret to have missed.

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